HEIDENHAIN

User's Manual

Diagnostics Kit

PWM 9

Software
508334-07

1/2012

Contents

1 General 7
1.1 How to Use these Operating Instructions 7
1.1.1 About these instructions 7
1.1.2 Update service 7
1.2 Safety Precautions 8
1.3 Calibration 10
1.4 Description of the Components 11
1.4.1 Contents of the PWM case 11
1.4.2 PWM basic unit 12
1.5 Items Supplied 13
1.6 Description of PWM 9 Phase-Angle Measuring Unit 16
1.7 PWM 9 Functions 17
1.8 Power Supply 18
1.9 Software 18
1.10 Description of the Displays 19

2 Determination of the Interface 21
2.1 How to Determine the Interface from the Encoder Designation 21
2.2 Other Identifiers 22

3 General Measuring Setup 23
3.1 Measuring Equipment 23
3.2 Connecting the Measuring Equipment 23

4 Basic Oscilloscope Settings 25
4.1 Requirements to the Oscilloscope 25
4.2 Analog Interfaces 1 Vpp and 11 µApp 25
4.2.1 Measuring incremental signals 25
4.2.2 Measuring the reference mark signal 26
4.2.3 Measuring TTL/HTL square-wave signals 27

5 Measuring with PWM 9 29
5.1 Measuring in PWT-MODE 11 µApp or 1 Vpp 29
5.1.1 Checking the signal quality in the PWT-MODE 30
5.1.2 Checking the signal amplitude in the PWT-MODE 31
5.1.3 Checking the reference mark signal in the PWT-MODE 33
5.1.4 Tolerances for measuring the reference mark signal (examples) 35
5.2 Adjustment Aid for Mounting the Scanning Head of Exposed Encoders 36
5.2.1 Preparations 37
5.2.2 Beginning of measurement 40
5.2.3 Basic adjustment 40
5.2.4 Measurement: One reference mark 41
5.2.5 Measurement: Multiple reference marks 42
5.2.6 Messages in the PWT-MODE 43
5.2.7 Errors during measurement 47
5.3 Measuring in the PWM MODE 49
5.3.1 Description of the PWM MODE display 50
5.3.2 Description of the soft-key row 51
5.3.3 Description of the INFO soft key 52
5.3.4 Description of the OPT soft key (options) 53
5.3.5 Assignment of the BNC sockets 54
5.3.6 Changing the BNC sockets and memory assignment 54
5.3.7 Possible assignments of the BNC sockets 55
5.3.8 Display of on-to-off ratio and phase shift 57
5.3.9 MODE display 59
5.3.10 UNIVERSAL COUNTER MODE 60
5.3.11 Mode DETERMINE PULSE NUMBER 61
5.3.12 MEASURE U/I mode 64

5.3.13 MEASURE AMPLITUDE mode 68
5.4 EXPERT MODE 73
5.4.1 Selecting EXPERT MODE functions 73
5.4.2 Changing the U-MSYS supply voltage 74
5.4.3 Input of PRESET VALUE 75
5.4.4 PEAK HOLD 76
5.4.5 Description of PARAMETER programming 78
5.4.6 Parameter settings 79
5.5 Measuring with the Multi-Functional Interface Board 1 Vpp, Absolute, Zn/Z1, EnDat, SSI 89
5.5.1 Encoders with Zn/Z1 track and 1 Vpp interface 89
5.5.2 Encoders with EnDat and 1 Vpp interface 90
5.5.3 Encoders with SSI and 1 Vpp interface (5 V operating voltage) 90
5.5.4 Encoders with programmable SSI and 1 Vpp interface (10 - 30 V operating voltage) 90
5.6 Operating the 1 Vpp Absolute Interface 91
5.6.1 Selecting the interface on the power-on screen 91
5.6.2 Selecting the interface via parameter 92
5.6.3 Fast changeover from AB to CD track 93
5.6.4 Possible settings when programmable SSI interface is selected 94

6 Activating Another PWM Measuring Mode 97
6.1 General Explanations of the Different Modes 97
6.2 Activating the PWT MODE 98
6.3 Switching from PWT MODE to PWM MODE 98
6.4 Switching from PWM MODE to PWT MODE 99
6.5 Activating the EXPERT MODE 100
6.6 Restoring the Factory Setting 100

7 Overview of the Adapter Cables 101
7.1 1 Vpp and TTL Interface Boards 101
7.2 11 µApp Interface Board 102
7.3 HTL Interface Board 103
7.4 Interface Board Absolute / 1 Vpp, Sinusoidal Commutating Signal Zn/Z1 104
7.5 Interface Board Absolute / 1 Vpp, Encoders EnDat / SSI / SSI Programmable; Measurement of the Absolute Signals at the Encoder Side 105
7.6 Interface Board Absolute / 1 Vpp, EnDat Encoders; Measurement at the Control Side 106
7.7 Interface Board Absolute / 1 Vpp, Motor Encoders EnDat / SSI / SSI Programmable 107
7.8 TNC with 15-Pin/25-Pin D-Sub Connectors and Interface Boards 1 Vpp, TTL, 11 µApp (Position Encoders) 108
7.9 TNC with 25-Pin D-Sub Connectors, Zn/Z1 (1 Vpp), EnDat (1 Vpp) (Motor Encoders) 109
7.10 Encoders with TTL –> 11 µApp Switch 110
7.10.1 Overview of TTL/11 µApp adapter cables and feed-through mode 111
7.10.2 Overview of adapter cables: Direct drives – incremental encoders 112
7.10.3 Overview of adapter cables: Direct drives – absolute encoders 113
7.11 FANUC TTL Adapter 114

8 Interface Description 115
8.1 Analog Interfaces 115
8.1.1 Incremental signals11 µApp 115
8.1.2 Incremental signals1 Vpp 117
8.1.3 Incremental signals1Vpp with commutating signals 121
8.2 Square-Wave Interfaces 122
8.2.1 Incremental signals TTL with square-wave interface 122
8.2.2 Incremental signals HTL with square-wave interface 125
8.3 Absolute Interfaces 128
8.3.1 Serial 128

8.3.2 Synchronuos serial SSI 138
8.3.3 Synchronous serial SSI programmable 140

9 Pin Layouts 145
9.1 Interface PCBs 145
9.2 Power Supply Connector (Female) 146
9.3 EnDat 2.1 147
9.4 SSI Serial Interface 148
9.5 Serial Interface SSI Programmable 148
9.6 Standard HEIDENHAIN Cables 149
9.7 Drive Encoders and Absolute Encoders 154
9.8 Adapter (Assignment Converter) for Non-HEIDENHAIN Wiring 156
9.9 Adapter Cable for Connecting the PWM to the PCB Connector of the Encoder 160
9.10 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Pos.Enc.EnDat) 164
9.11 Adapter Cable to IK 115 / IK 215 Interface Card 165
9.12 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Mot.Enc.EnDat) 166
9.13 Adapter Cable 17-Pin/15-Pin; PWM to Subsequent Electronics (Pos.Enc.EnDat) 167
9.14 Adapter Cable 17-Pin/25-Pin; PWM to Subsequent Electronics (Mot.Enc.1 Vpp) 168
9.15 Adapter Cable 17-Pin/25-Pin; PWM to Subsequent Electronics (Mot.Enc.EnDat) 169
9.16 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Mot.Enc.1 Vpp) 170
9.17 Adapter Cable 17-Pin/15-Pin; TNC with 15-Pin D-Sub Connector (Pos.Enc. 1 Vpp/EnDat) 171
9.18 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/ZnZ1) 172
9.19 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/EnDat) 173
9.20 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/EnDat and 1 Vpp/ZnZ1) 174
9.21 Adapter Cable 12-Pin/15-Pin; PWM to TTL D-Sub Subsequent Electronics (Pos.Enc.) 175
9.22 Adapter Cable 12-Pin/15-Pin; PWM to TTL Interface Electronics (APE) D-Sub (Pos.Enc.) 176
9.23 Adapter Cable 12-Pin/12-Pin; PWM to TTL Interface Electronics (APE) (Pos.Enc.) 177
9.24 Adapter Cable 12-Pin/14-Pin; PWM to Encoders with M12 Connectors (1 Vpp / TTL) 178
9.25 Adapter Cable 17-Pin/14-Pin; PWM to Encoders with M12 Connectors (EnDat) 179
9.26 Adapter Cable 12-Pin/12-Pin; PWM to PCB Connector (1 Vpp, TTL, HTL) (Pos.Enc.) 180
9.27 Adapter Cable 25-Pin D-Sub (Mot.Enc.); 12-pPin (Pos.Enc.) for PWM IN 181
9.28 Adapter Cable 15-Pin D-Sub (Pos.Enc.); 12-Pin (Pos.Enc.) for PWM OUT 182
9.29 Adapter Cable 15-Pin D-Sub (Pos.Enc.); 9-Pin (Pos.Enc.) for PWM OUT 183
9.30 Round Adapter, 9-Pin/15-Pin D-Sub Connector (Pos.Enc./Pos.Enc) (11 µApp) 184
9.31 Round Adapter, 12-Pin/15-Pin D-Sub Connector (Pos.Enc./Pos.Enc) (1 Vpp / TTL) 185
9.32 Adapter Cable TTL/D-Sub 15-Pin (Pos.Enc.) –> 11 µApp M23 9-Pin (Pos.Enc.) 186
9.33 Adapter TTL M23 12-Pin (Pos.Enc.) –> 11 µApp M23 9-Pin (Pos.Enc.) 187
9.34 Adapter Cable FANUC TTL 20-Pin/ HEIDENHAIN TTL 12-Pin 188

10 FST 2 Leak Tester 189
10.1 Description 189
10.2 Explanation of the Control Elements 189
10.3 Application Example 190
10.4 Specifications 191

11 Rotary Encoder ROD 486 193
11.1 Description 193
11.2 Specifications 193

12 Specifications 195
12.1 PWM 9 Basic Unit 195
12.2 11 µApp Interface Board 198
12.3 1 Vpp Interface Board 199
12.4 1 Vpp Absolute Interface Board 201
12.5 TTL Interface Board 203
12.6 HTL Interface Board 204
12.7 PWM Power Supply Unit 205

13 Contact 207
13 Your HEIDENHAIN helpline 207
13 The HEIDENHAIN technical helpline 207
13 The HEIDENHAIN helpline for
repairs, spare parts, exchange units, complaints and service contracts 207
13 Technical training 207

1 General

1.1 How to Use these Operating Instructions

1.1.1 About these instructions

This manual applies to:

- PWM 9 with software 508334-07

1.1.2 Update service

These instructions are regularly updated.

Printed copies are only distributed to the participants of our service training courses and are enclosed with new PWM 9 units.

Note

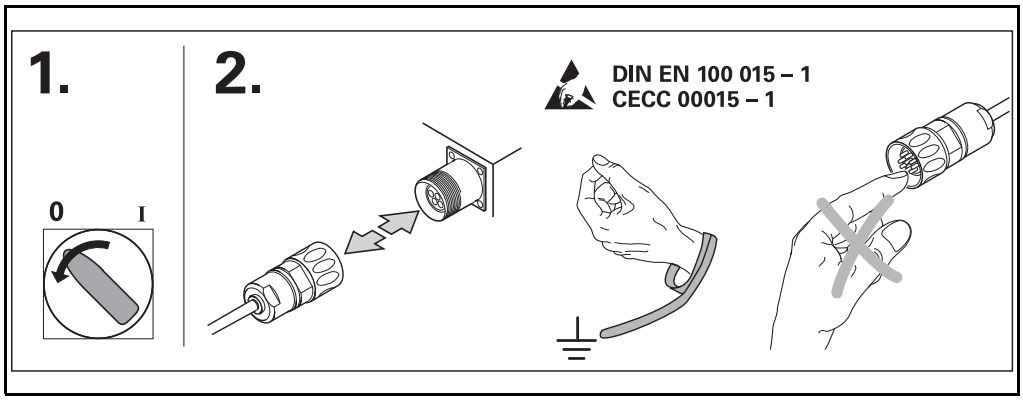
The current (printable) version is available on the Internet in PDF format:
www.heidenhain.de

1.2 Safety Precautions

Do not operate defective units!

When connecting a PWM9 to the position control loop of an NC-controlled machine tool:

1. Switch off the machine!
2. Then disengage the connecting elements!



DANGER

Do not operate the device, if power cord, power supply unit or PWM are damaged!

Do not change any parameters or encoder voltages at the PWM while the machine tool is moving and a PWM is connected to the position control loop! Ignoring this may cause machine damage or personal injury!
Always secure vertical axes to prevent them from falling down before tests are performed with these axes!

The components inside PWM9 are maintenance-free. Do not open the PWM9 housing!

Attention

Correct evaluation of the malfunction of an NC-controlled machine requires fundamental knowledge about the machine tool, its drives, inverters and NCs as well as their interaction with the measuring systems.

Improper operation of the NC, incorrect NC programming or incorrect or non-optimized machine parameter values can lead to faulty machine performance.

Careless treatment or use may cause considerable damage or injury to property or persons. Apart from the instructions in this manual the general instructions for safety and the prevention of accidents must be observed!

Note

HEIDENHAIN can accept no responsibility for direct or indirect damage or injury caused to property or persons through improper use or incorrect operation of the machine.

The machine manufacturer must be contacted for error diagnosis.

However, support will also be provided by HEIDENHAIN Traunreut or by the HEIDENHAIN agencies.
Telephone and fax numbers and e-mail addresses: see “Contact” on page 207 of this manual or refer to www.heidenhain.de on the Internet.

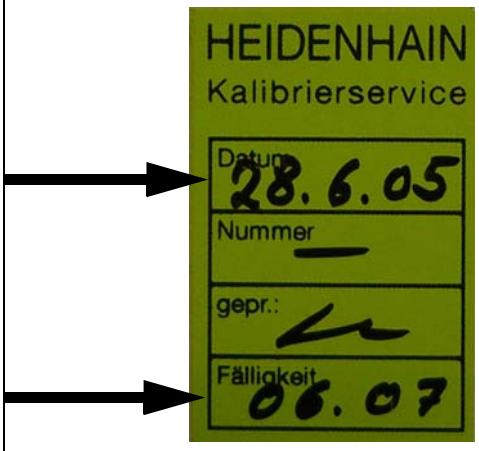
1.3 Calibration

In general the PWM is maintenance-free, since it does not contain any components that are subject to wear.

To ensure exact and correct operation we recommend sending the PWM incl. the interface boards to the calibration service of HEIDENHAIN Traunreut every 2 years.

Note

Calibration includes a software update!

Calibration sticker on PWM 9	
Calibration sticker on the interface board	
Date of calibration Next recommended calibration date	

1.4 Description of the Components

1.4.1 Contents of the PWM case

Note

The photos show the contents of the case with optional accessories!

1.4.2 PWM basic unit

3 BNC sockets
(connection to oscilloscope)

LC display
(back-lighted)

5 Soft keys
(to select type of measurement)

Aluminum housing

Tilting handle for carrying and placing

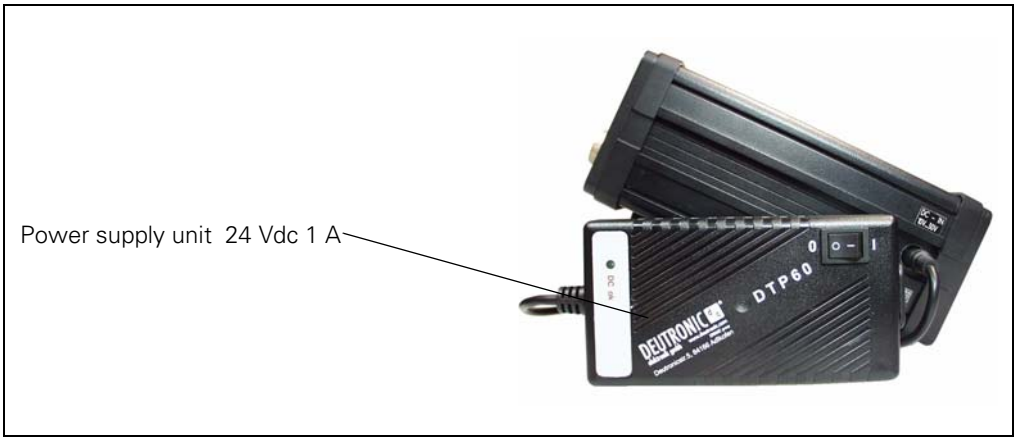
Pull in arrow direction to undo the lock!

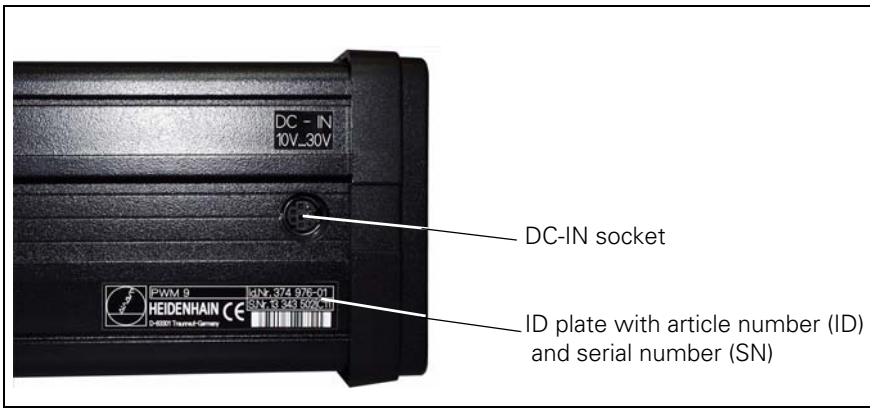
3 BNC sockets A/B/C
(connection to oscilloscope)

Interface board in PWM module slot

Unlocking device for interface board

IN/OUT for encoder / subsequent electronics (with protective cap)





Note

State the ID number in all requests!

1.5 Items Supplied

The PWM 9 Universal test unit ID 512134-01 consists of:

Qty.	Description	ID
1	PWM 9 (basic unit)	374976-01
1	Power supply unit (100 - 240 V)	313797-04
1	Power cable (3 m)	223775-01
1	Adapter cable (10 - 30 Vdc, 3 m)	317293-01
3	BNC connecting cable	254150-02
1	Connecting cable 9-pin (11 µApp) see 7.2	309773-01
1	Connecting cable 12-pin (1 Vpp, TTL) see 7.1, see 7.3	298399-01
1	Connecting cable 17-pin (absolute, 1 Vpp) see 7.4 see 7.5, see 7.7, see 7.9	323897-01
1	Aluminum case	313795-02
1	Operating instructions, German	517651-0x
1	Operating instructions, English	517651-2x

Options

Qty.	Description	ID
1	Operating instructions, French	517651-3x
1 1 1	**11 µApp interface board** **Recommended accessories:** FST 2 leak tester Adapter connector 1 Vpp / 11 µApp see 11.1	 251697-01 364914-02
1	Adapter connector 15-pin D-sub (Pos.Enc.); 9-pin (Pos.Enc.) for PWM IN see 7.2, see 7.8	294894-02
1	Adapter cable 2 m 15-pin D-sub (Pos.Enc.); 9-pin (Pos.Enc.) for PWM OUT see 7.8	310198-02 289439-02
1 1 1	**1 Vpp interface board** **Recommended accessories:** ROD 486 (1000 lines) Adapter connector Female connector / male connector (1 Vpp or TTL) see 7.1, see 7.3	**323077-02** 376886-0H 373848-01
1	Adapter cable 12-pin/15-pin; PWM to TTL D-sub subsequent electronics (Pos.Enc.) see 7.10.1	310196-xx
1	Adapter cable 12-pin/15-pin; PWM to TTL interface electronics (APE) D-sub (Pos.Enc.) see 7.10.1	331693-xx
1	Adapter cable 12-pin/12-pin; PWM to TTL interface electronics (APE) (Pos.Enc.) see 7.10.1	323466-xx
1	Adapter cable 2 m 15-pin D-sub (Pos.Enc.); 12-pin (Pos.Enc.) for PWM OUT see 7.8	310199-02
1	Adapter cable 1 m 25-pin D-sub (Pos.Enc.); 12-pin (Pos.Enc.) for PWM IN see 7.8	533055-01
1	Adapter, round 12-pin/15-pin D-sub connector (Pos.Enc./Pos.Enc) (1 Vpp/TTL) see 7.1, see 7.8	324555-01
1	Adapter cable 12-pin/14-pin; PWM to encoders with M12 connectors (1 Vpp/TTL), (Pos.Enc.) see 7.1	352611-03
1	Adapter cable 12-pin/12-pin; PWM to PCB connector (1 Vpp, TTL, HTL) (Pos.Enc.) see 7.3	591118-xx
1	**TTL interface board** Adapter cable FANUC TTL 20-pin/ HEIDENHAIN TTL 12-pin	**323079-01** 577345-01
1	**HTL interface board**	**322732-01**
1 1 1 1 1 1 1	**Absolute/1 Vpp interface board** **Recommended accessories:** Adapter connector Zn / Z1 transforms Mot.Enc. into Pos.Enc. see 7.4 Adapter connector Zn / Z1 transforms Pos.Enc. into Mot.Enc.) see 7.4 Adapter connector EnDat/SSI transforms Mot.Enc. into Pos.Enc. see 7.4 Adapter connector EnDat/SSI transforms Pos.Enc. into Mot.Enc. see 7.4 Connecting cable 1 m: incremental Zn / Z1 (Mot.Enc.) see 7.4 Connecting cable 1 m: absolute EnDat (Mot.Enc.) see 7.7	**312186-02** 349312-01 349312-02 349312-03 349312-04 336847-10 340302-01
1	Adapter 1 m with 12-pin PCB connector for 1 Vpp encoders (EnDat or SSI; Pos.ENC.EnDat) see 7.7	349839-02

Qty.	Description	ID
1	Adapter 1 m with 14-pin PCB connector for 1 Vpp encoders with Zn/Z1 track (Pos.Enc.EnDat) see 7.4	330980-01
1	Adapter 1 m with 15-pin PCB connector for absolute encoders (EnDat or SSI; Pos.ENC.EnDat) see 7.7	635349-01
1	Adapter cable 3 m 17-pin/17-pin; PWM to motor (Pos.Enc.EnDat) see 7.4, see 7.5	323897-03
1	Adapter cable 2 m to IK 115 interface card see 7.5, see 7.7	324544-02
1	Adapter cable 3 m 17-pin/15-pin; PWM to subsequent electronics (Mot.Enc.EnDat) see 7.5, see 7.6	332115-03
1	Adapter cable 0.3 m 15-pin D-sub (Pos.Enc.), 17-pin (Pos.Enc.) for PWM OUT see 7.5, see 7.6	510617-N3
1	Adapter cable 3 m 17-pin/25-pin; PWM to subsequent electronics (Mot.Enc.1 Vpp) see 7.4, see 7.9	289440-03
1	Adapter cable 3 m 17-pin/25-pin; PWM to subsequent electronics (Mot.Enc.EnDat) see 7.7, see 7.9	336376-03
1	Adapter cable 0.3 m 25-pin D-sub (Mot.Enc.), 17-pin (Pos.Enc.) for PWM IN see 7.9	509666-N3
1	Adapter cable 0.3 m 25-pin D-sub (Mot.Enc. 1 Vpp/EnDat), 17-pin (Pos.Enc. 1 Vpp/EnDat) for PWM OUT see 7.9	509667-N3
1	Adapter cable 0.3 m 25-pin D-sub (Mot.Enc. 1 Vpp/ZnZ1), 17-pin (Pos.Enc. 1 Vpp/ZnZ1) for PWM OUT see 7.9	511886-N3
1	Adapter cable 0.3 m 15-pin D-sub (Pos.Enc.), 17-pin (Pos.Enc.) for PWM IN see 7.6	510616-N3
1	Voltage controller 5 V for cable lengths > 6 m (Pos.Enc.EnDat) HEIDENHAIN see 7.5, see 7.7	370225-01
1	Voltage controller 5 V for cable lengths > 6 m (Mot.Enc.EnDat); SIEMENS see 7.5	370224-01

Other connecting cables and adapter cables: See illustrations in this manual.

Note

Other cable lengths on request!
Application of the adapter cables: see "Overview of the Adapter Cables" on page 101.

1.6 Description of PWM 9 Phase-Angle Measuring Unit

PWM 9 is a universal measuring unit for inspecting and adjusting HEIDENHAIN incremental linear and angle encoders.

The unit features **PWT-MODE** and **PWM-MODE** functionalities.

The graphic bar display in the PWT-MODE facilitates the quantitative and qualitative assessment of the analog incremental signals and of the reference signal. The integrated adjustment aid (PWT-MODE) for exposed encoders is of help when mounting the scanning head.

In the PWM-MODE on-to-off ratio, phase angle, encoder current consumption and encoder voltage are measured and settings made that are relevant for PWM 9.

A number of interface boards are available for checking the different encoder output signals; they can be inserted easily into the PWM from outside.

The values can be read on an LCD monitor. Five soft keys provide ease of operation.

Three BNC sockets (A/B/C) are available for checking the encoder output signals on an oscilloscope (recommended by HEIDENHAIN).

PWM 9 can be connected in series between the encoder and the subsequent electronics.

The axis functions of the machine axes are not influenced.

For inspecting and adjusting HEIDENHAIN measuring systems "at the workplace" PWM 9 can also be used without subsequent electronics.

1.7 PWM 9 Functions

PWM 9 features three operating modes:

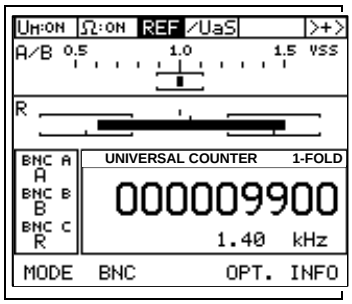
PWT MODE (power-on MODE)

Graphic bar display of

- Signal amplitude
- Signal quality
- Width of reference signal
- Position of reference signal

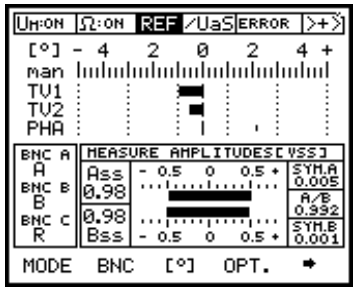
Check-Ref function

- Adjusting aid for mounting scanning heads of exposed encoders
- Checking distance-coded reference marks



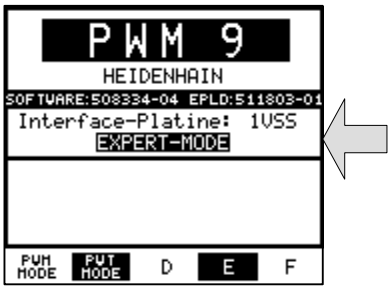
PWM MODE

- Display of phase angle and on-to-off ratio
- Display of scanning frequency
- Display of signal amplitude, current consumption and encoder supply voltage
- Display of internal UNIVERSAL COUNTER and of encoder signal periods (pulse number)
- Display of reference signal, fault-detection signal and counting direction
- Output of the amplified scanning signals (11 µApp, 1 Vpp interface board) or of the original scanning signals (TTL, HTL interface board) via 3 BNC sockets (e.g. to an oscilloscope)



EXPERT MODE

- Access to parameter programming (e.g. interpolation setting)
- Input of a preset value for the internal UNIVERSAL COUNTER
- Setting the encoder voltage
- Min./max. PEAK-HOLD function of the PHA/TV display



1.8 Power Supply

Possibilities of powering PWM 9

- Line operation via 24 V PWM power supply unit (supplied with PWM 9)
- Power supply from an external floating DC voltage source 10 - 30 V / approx. 1 A (adapter cable supplied with PWM 9)
- Via subsequent electronics with measuring system, PWM 9 and subsequent electronics connected in series.
  (Caution: Power consumption of PWM 9: approx. 5.5 W)
  The type of encoder power supply (PWM or subsequent electronics) is selected via the PWM 9 soft keys.
  If a voltage is connected to the DC-IN socket of PWM 9, the PWM 9 basic unit is always powered from this source.

If PWM 9 and/or the measuring system are to be powered by the subsequent electronics,

- the encoder voltage monitor of the subsequent electronics is active.
- you can select how the encoder voltage of the subsequent electronics is fed to the encoder via PWM 9:
  1. Directly to the encoder (with parameter P2 in EXPERT-MODE and soft key)
  2. Via the switching controller (integrated in PWM 9) with potential segregation and possibility of setting the encoder voltage.

Note

Detailed description:
see "Parameter P2 = Selection of encoder operating voltage" on page 79!

1.9 Software

The software version is displayed on the power-on screen and when you press the INFO soft key (see "Description of the INFO soft key" on page 52).

On the power-on screen the PWM 9 offers the possibility of selecting German, English or French dialogs:

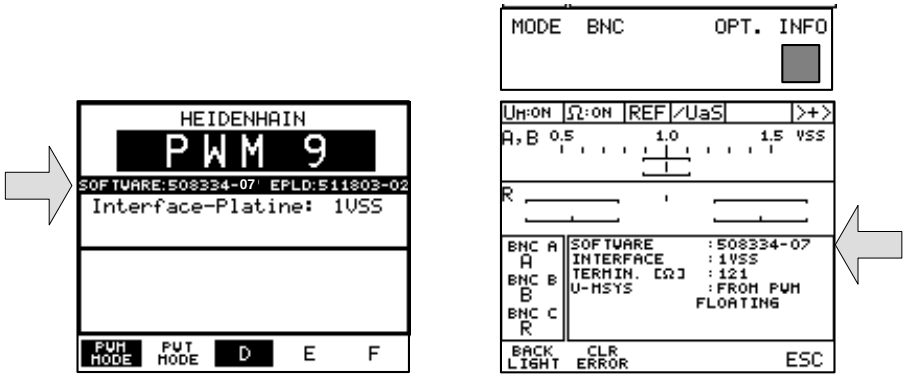
Dialog	Software no.
German / English / French	508334-xx [a]

a) The last two digits (xx) of the software number represent the software version.

The software is continuously improved and adapted to new conditions.
We recommend that at least every 2 years you have the software updated by HEIDENHAIN Traunreut or by a HEIDENHAIN agency. (See "Calibration" on page 10.)

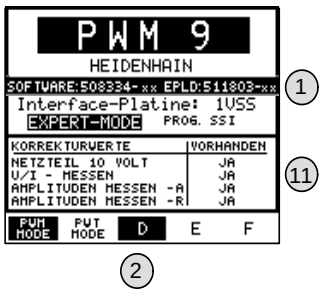
Attention

This manual applies to PWM 9 with the software 508334-07.



1.10 Description of the Displays

Power-on screen



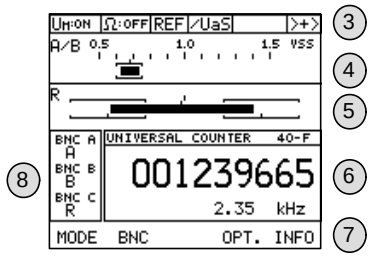
(1) Display of software no.
Type of interface board (here: 1 Vpp)
Info EXPERT MODE active

(2) PWM / PWT switchover and language selection

(PWM / PWT switchover also possible in (7) "INFO")

(11) Internal calibration values (JH Service only)

PWT MODE



(3) Concurrent encoder status display

(4) Signal amplitude / signal quality

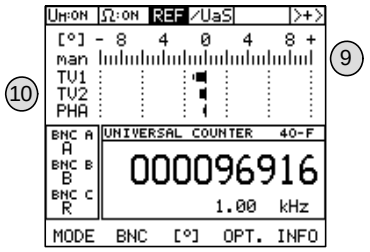
(5) Width and position of ref. mark

(6) Display for different PWM modes
(here: *UNIVERSAL COUNTER* and frequency)

(7) Soft-key row for operation

(8) Current assignment of the BNC sockets

PWM MODE



(9) Measuring range and scaling
of PHA / TV display

(10) Display of **PHA**se shift / **T**ast**V**erhältnis (on-to-off ratio)

TV1 = 0° signal
TV2 = 90° signal

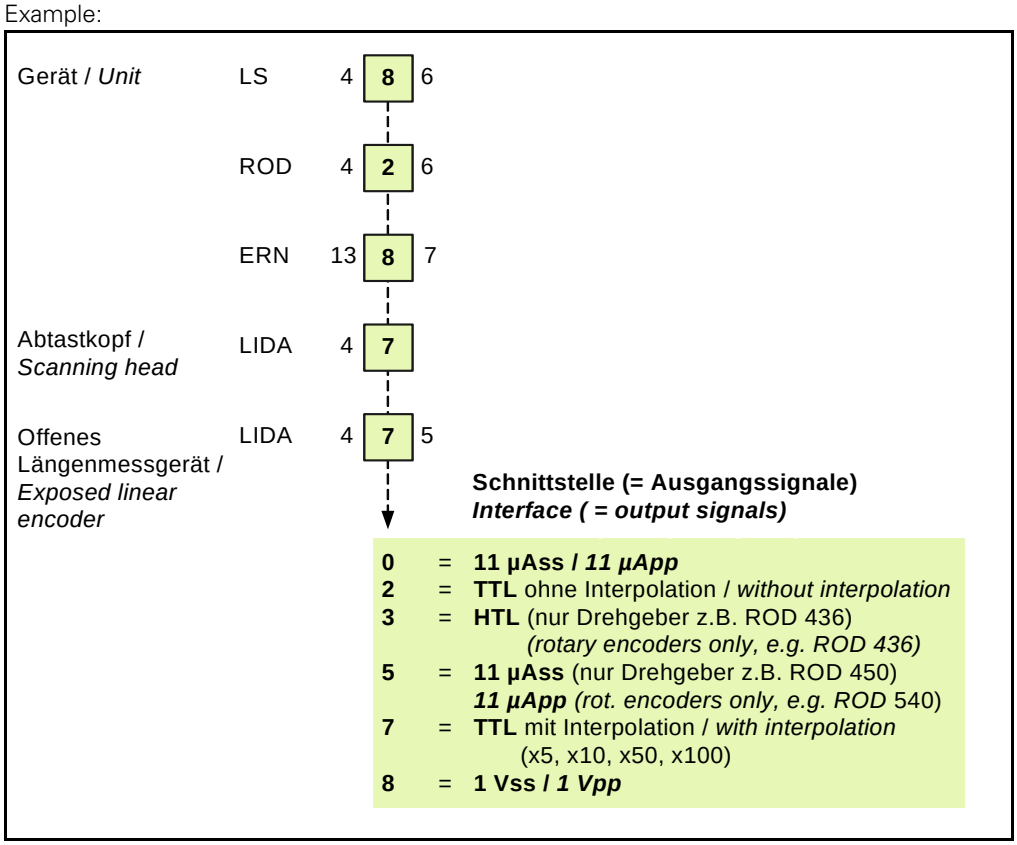
2 Determination of the Interface

2.1 How to Determine the Interface from the Encoder Designation

Note

The determination of the interface type applies to standard HEIDENHAIN encoders. Deviations from the designation structure are possible (in particular as regards customized measuring systems).

Example:


Gerät / Unit
LS 4 8 6
ROD 4 2 6
ERN 13 8 7
Abtastkopf / Scanning head
LIDA 4 7
Offenes Längenmessgerät / Exposed linear encoder
LIDA 4 7 5
Schnittstelle (= Ausgangssignale)
Interface (= output signals)
0 = 11 µAss / 11 µApp
2 = TTL ohne Interpolation / without interpolation
3 = HTL (nur Drehgeber z.B. ROD 436)
(rotary encoders only, e.g. ROD 436)
5 = 11 µAss (nur Drehgeber z.B. ROD 450)
11 µApp (rot. encoders only, e.g. ROD 540)
7 = TTL mit Interpolation / with interpolation
(x5, x10, x50, x100)
8 = 1 Vss / 1 Vpp

Note

With 2-digit unit designations the last digit represents the interface; with designations consisting of 3 or more places the last but one digit is decisive.

2.2 Other Identifiers

- A **9-pin** connector always means an **11 µApp interface**!

- To the encoder inputs of **EXE** interpolation electronics always **11 µApp encoders** are connected.
- To the encoder inputs of **IBV** interpolation electronics always **1 Vpp encoders** are connected.
- Encoders that have a 'C' or a 'Q' in their names use an absolute interface (EnDat or SSI).

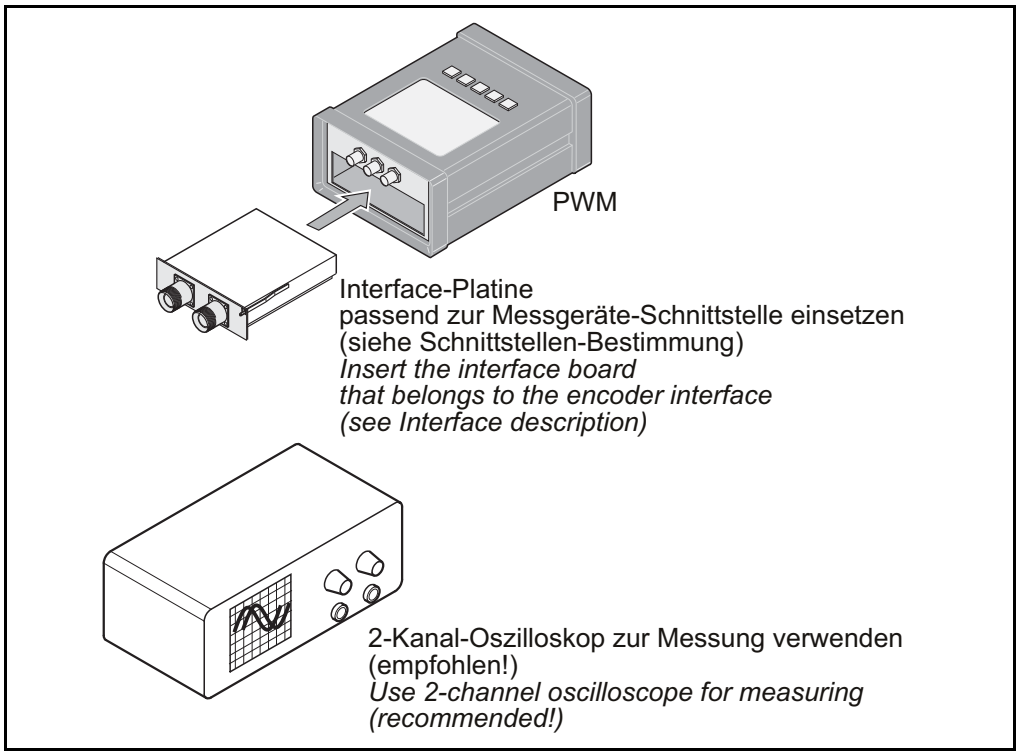
Example:

L	C		481
RO	C		413
E	C	N	413
RO	Q		425
E	Q	N	425

Encoders with absolute EnDat, SSI or programmable SSI interface can be connected to PWM 9.

3 General Measuring Setup

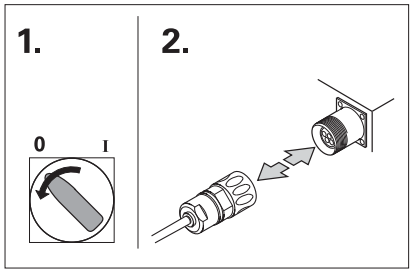
3.1 Measuring Equipment



3.2 Connecting the Measuring Equipment

DANGER

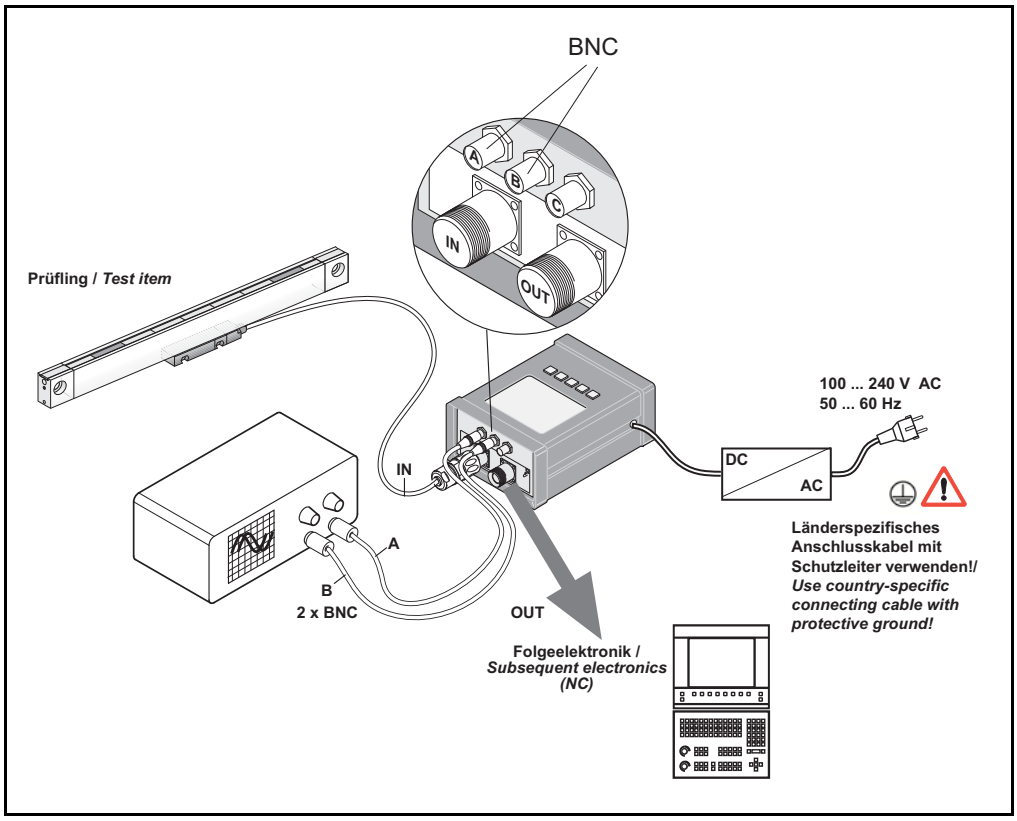
Ensure that machine and PWM are off when you connect the equipment!



DANGER

Do not deactivate or alter any voltages or parameters at the PWM, while operating the PWM in the position control loop!

Uncontrolled axis movements may occur!



- Connect the measuring system to be tested to the "IN" input of the PWM.
- Connect the oscilloscope to the PWM (BNC A and BNC B) using two BNC cables.
- Connect the subsequent electronics to PWM "OUT".
- Switch the PWM power supply unit on.
- Switch the subsequent electronics on.

Note

For connection to the power supply system the protective ground of the PWM 9 must be connected. (Do not use an isolating transformer!) Otherwise, signal errors may be produced!
If possible, use the power socket on the machine to power the PWM.
Power the PWM 9 and the oscilloscope from the same power socket.

4 Basic Oscilloscope Settings

4.1 Requirements to the Oscilloscope

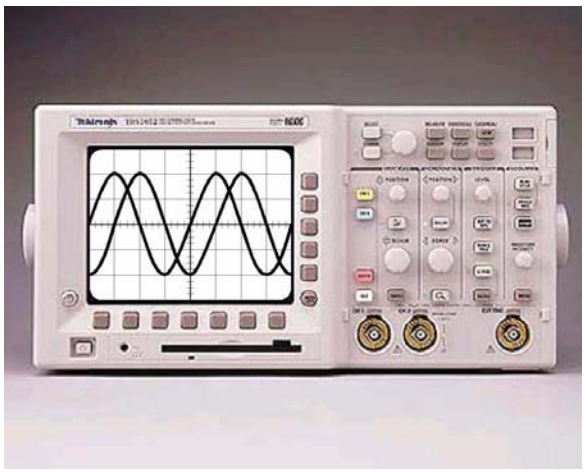
- Analog or digital 2-channel storage oscilloscope (DSO)
- Chopper mode
- Automatic and manual triggering

Note

Supportive measurement with an oscilloscope is recommended!

4.2 Analog Interfaces 1 Vpp and 11 µApp

4.2.1 Measuring incremental signals



Note

The designation of the controls of the oscilloscope is not standardized and may be different on your model!

Vertical deflection (Voltage sensitivity)

- Switch channels A and B to Chopper mode (**CHOP**).
- Set the deflection coefficient (**Sensitivity**) of channels A and B.
  For 11 µApp encoder: 0.5 V/DIV
  For 1 Vpp encoder: 0.2 V/DIV

Horizontal deflection (Time setting)

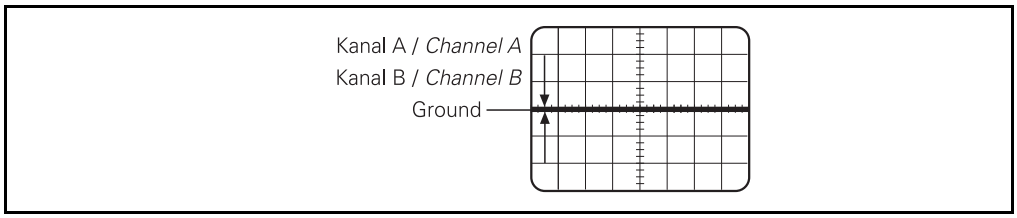
- Set the time coefficient (**Time basis**) to **0.5 ms/DIV**.

Triggering

- Automatic (**AUTO**) triggering
- Trigger on **channel A**
- Trigger on **positive edge**

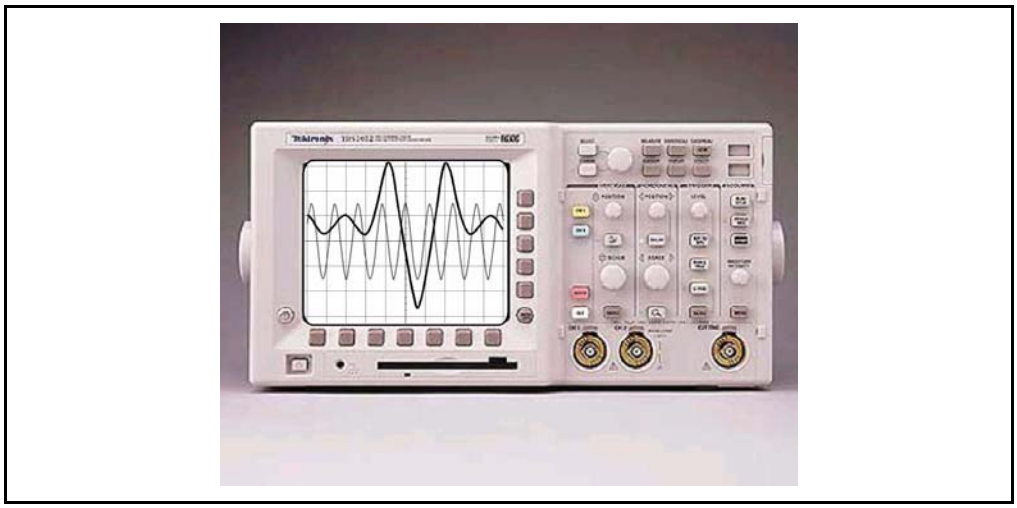
Calibrating the 2 oscilloscope channels

- Set the input coupling switch (AC/DC/GND) of the channels A and B to ground (**GND**).
- Use the Y-position potentiometers to shift the lines of the channels A and B congruently to the **screen center** (see fig.)



- Set the input coupling switch (AC/DC/GND) of the channels A and B to (**DC**).

4.2.2 Measuring the reference mark signal



Vertical deflection (Voltage sensitivity)

- Switch channels A and B to Chopper mode (**CHOP**).
- Set the deflection coefficient (**Sensitivity**) of channels A and B.
  For 11 µApp encoder: 0.5 V/DIV
  For 1 Vpp encoder: 0.2 V/DIV

Horizontal deflection (Time setting)

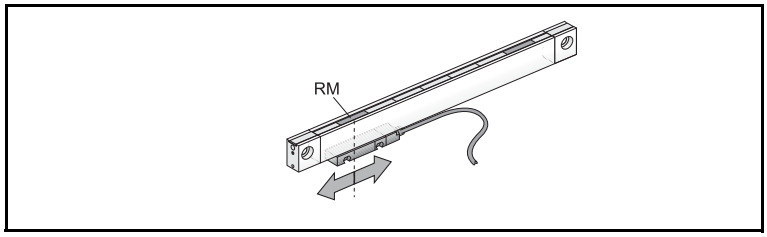
- Set the time coefficient (**Time basis**) to **0.5 ms/DIV**.

Triggering

- **Manual triggering** (AC or DC)
- Trigger on **channel A**
- Trigger on **negative edge**

Note

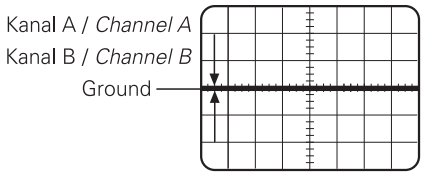
Traverse the reference mark to be checked in an "oscillatory" way (forward/backward).



Turn the trigger potentiometer of the oscilloscope to set the trigger threshold (LEVEL) such that the reference mark signal is displayed as a "stationary" image on the screen.
You may have to "pre-trigger", if you use a digital storage oscilloscope (DSO).
The sine-wave display of Ue1+2 on the scope does not equal the actual amplitude height.
Ue1+2 serves as an ancillary signal for measuring the reference mark width and position.

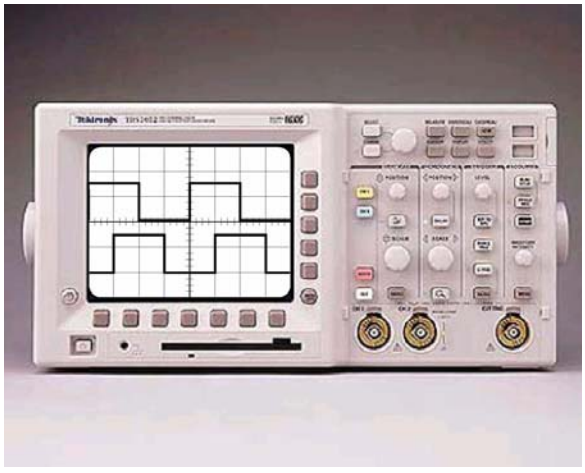
Calibrating the 2 oscilloscope channels

- Set the input coupling switch (AC/DC/GND) of the channels A and B to **GND** (⊥ or 0).
- Use the Y-position potentiometers to shift the lines of the channels A and B congruently to the **screen center** (see fig.)



- Set the input coupling switch (AC/DC/GND) of the channels A and B to (**DC**).

4.2.3 Measuring TTL/HTL square-wave signals



Note

The oscilloscope setting is the same for incremental signals and reference mark signals.

Vertical deflection (Voltage sensitivity)

- Switch channels A and B to Chopper mode (**CHOP**).
- Set the deflection coefficient (**Sensitivity**) of channels A and B.
  For TTL: 2 V/DIV
  For HTL: Sensitivity depends on supply voltage (10 ... 30 V)

Horizontal deflection (Time setting)

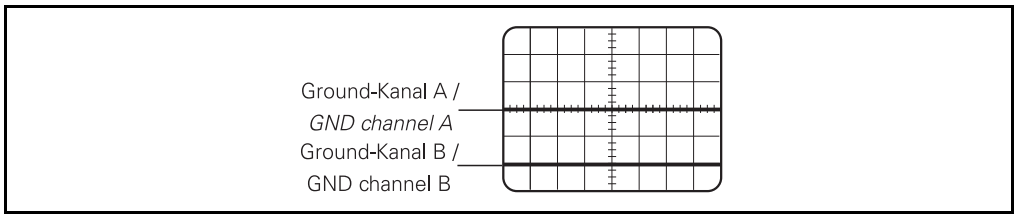
- Set the time coefficient (**Time basis**) to **0.5 ms/DIV**.

Triggering

- Automatic (**AUTO**) triggering
- Trigger on **channel A**
- Trigger on **positive edge**

Calibrating the 2 oscilloscope channels

- Set the input coupling switch (AC/DC/GND) of the channels A and B to ground (**GND**).
- Use the Y-potentiometers to shift the line of channel A e.g. to the screen center and the line of channel B to the lower grid line (see fig.)



- Set the input coupling switch (AC/DC/GND) of the channels A and B to (**DC**).

5 Measuring with PWM 9

5.1 Measuring in PWT-MODE 11 µApp or 1 Vpp

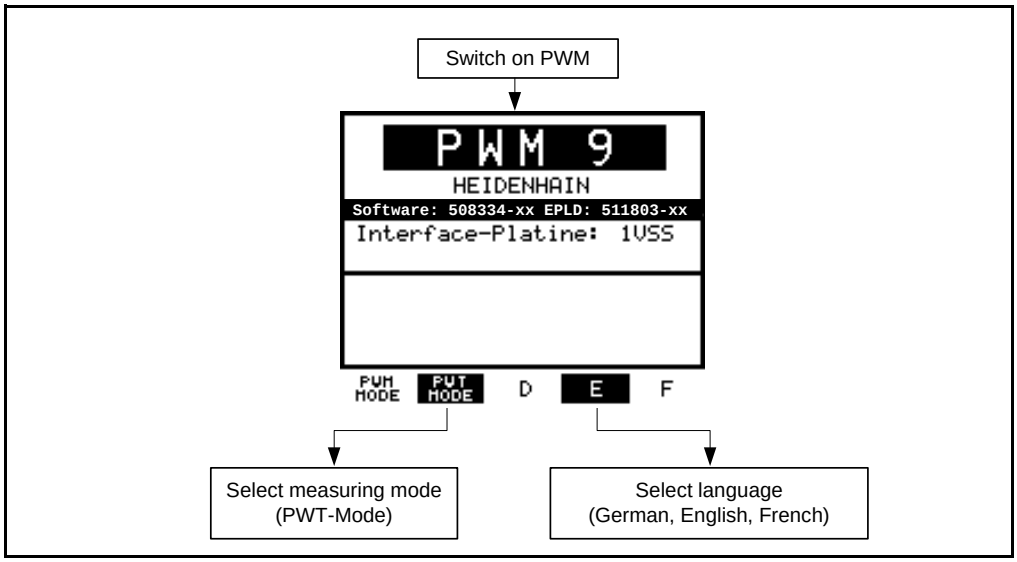
Note

In the PWT-MODE only analog interfaces can be measured (11 µApp and 1 Vpp).

The stated tolerances (ranges within the brackets) are standard values!
The tolerances of measuring systems for high resolutions (e.g. angle encoders) and large temperature ranges (e.g. motor encoders) are tighter! In this case the limits formed by the brackets are invalid.
Encoders with tighter tolerances must be checked in the PWM mode.

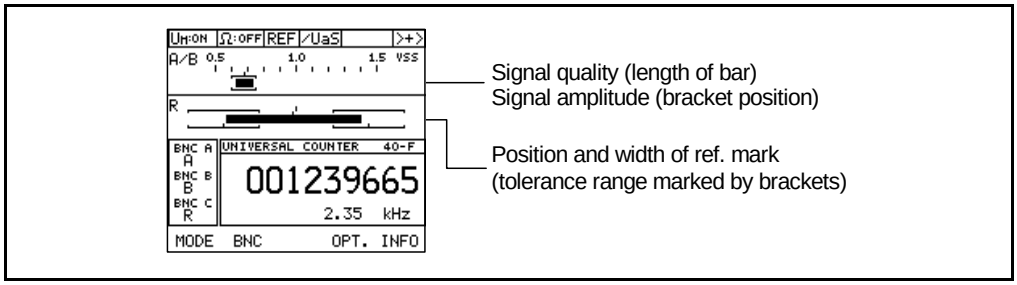
The PWM only works, if the interface board is inserted!

The PWT-MODE serves to check analog signals and reference marks and it assists you in mounting measuring systems (in particular "exposed systems").



Display in PWT MODE

- Signal amplitude
- Signal quality
- Reference mark position
- Width of the reference marks



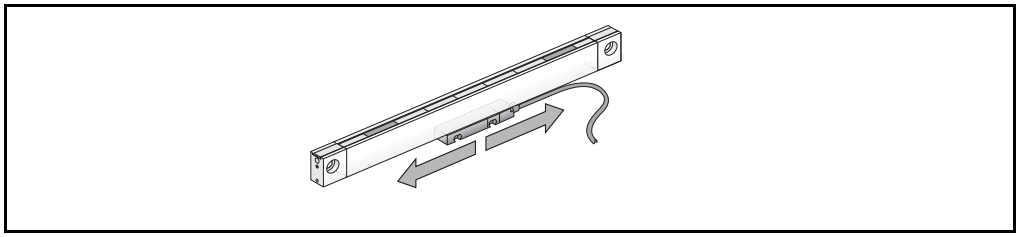
Note

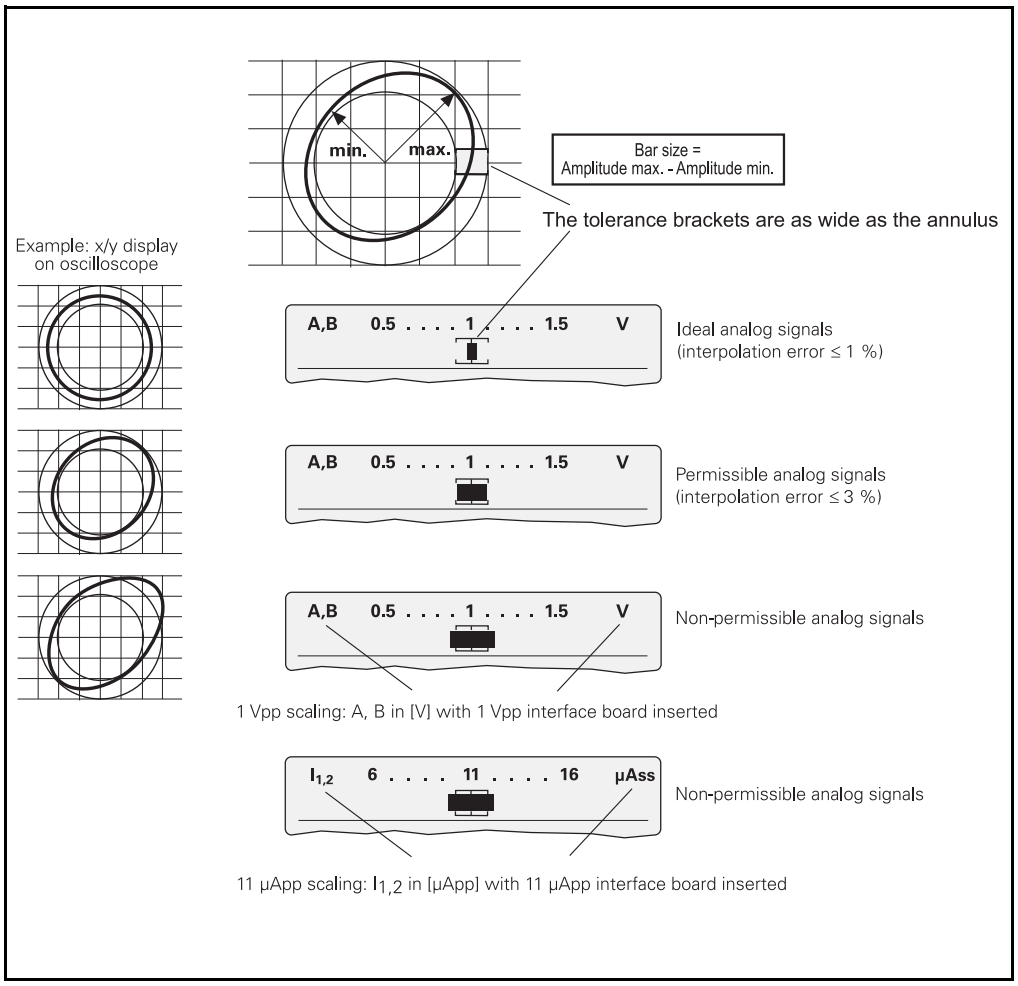
For more information on the display, see chapter "Measuring in the PWM MODE" on page 49.

5.1.1 Checking the signal quality in the PWT-MODE

Note

The measuring system must be moved to make a statement on the signal quality.




min.
max.
Bar size =
Amplitude max. - Amplitude min.
The tolerance brackets are as wide as the annulus
Example: x/y display
on oscilloscope
A,B 0.5 . . . . 1 . . . . 1.5 V
Ideal analog signals
(interpolation error ≤ 1 %)
A,B 0.5 . . . . 1 . . . . 1.5 V
Permissible analog signals
(interpolation error ≤ 3 %)
A,B 0.5 . . . . 1 . . . . 1.5 V
Non-permissible analog signals
1 Vpp scaling: A, B in [V] with 1 Vpp interface board inserted
I1,2 6 . . . . 11 . . . . 16 µAss
Non-permissible analog signals
11 µApp scaling: I1,2 in [µApp] with 11 µApp interface board inserted

Note

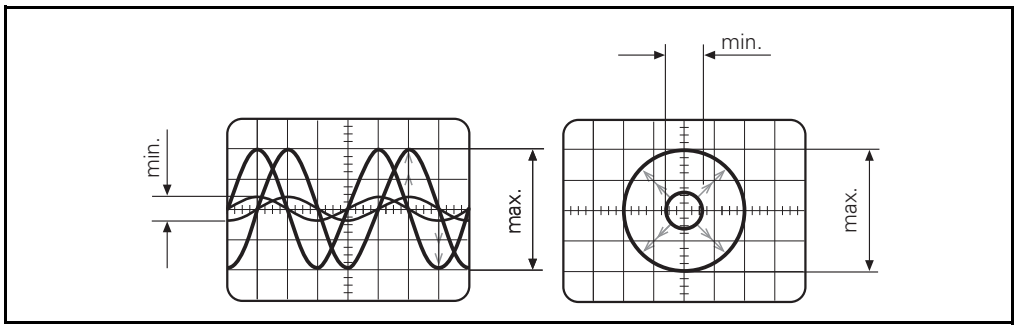
- The bar has to be within the brackets.
- The shorter the bar, the better is the signal quality.
- Tolerance range see “Interface Description" on page 115.

5.1.2 Checking the signal amplitude in the PWT-MODE

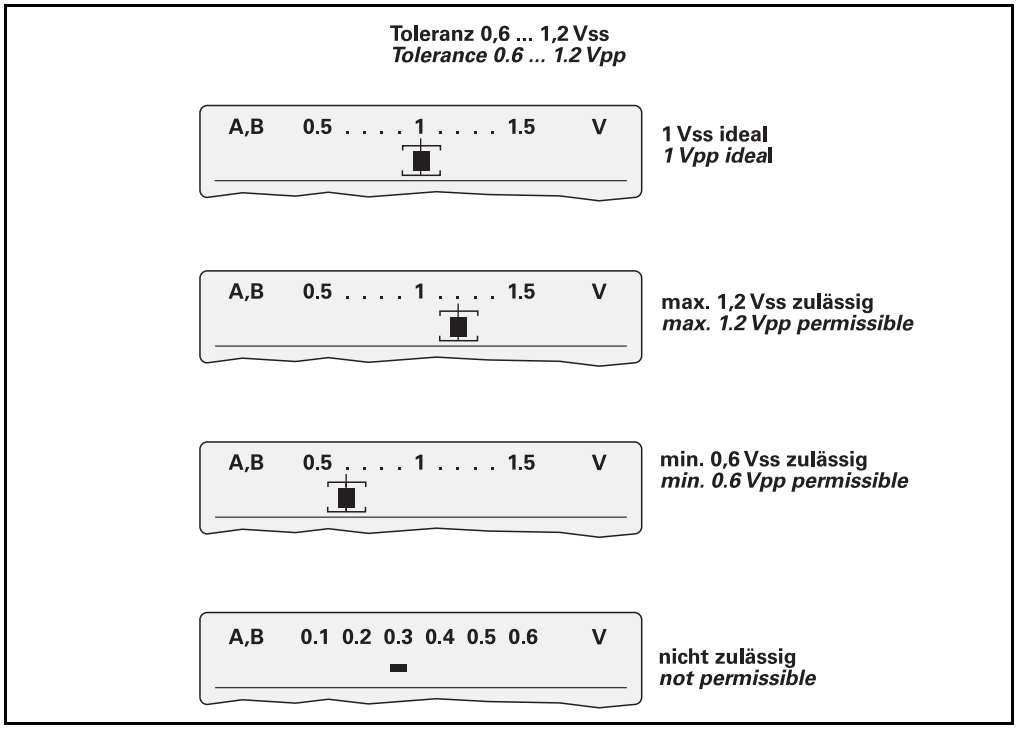
Note

The signal amplitude can also be measured **at standstill**!
Tolerance range: see “Interface Description" on page 115.
11 µApp or 1 Vpp signals are measured depending on the interface board.

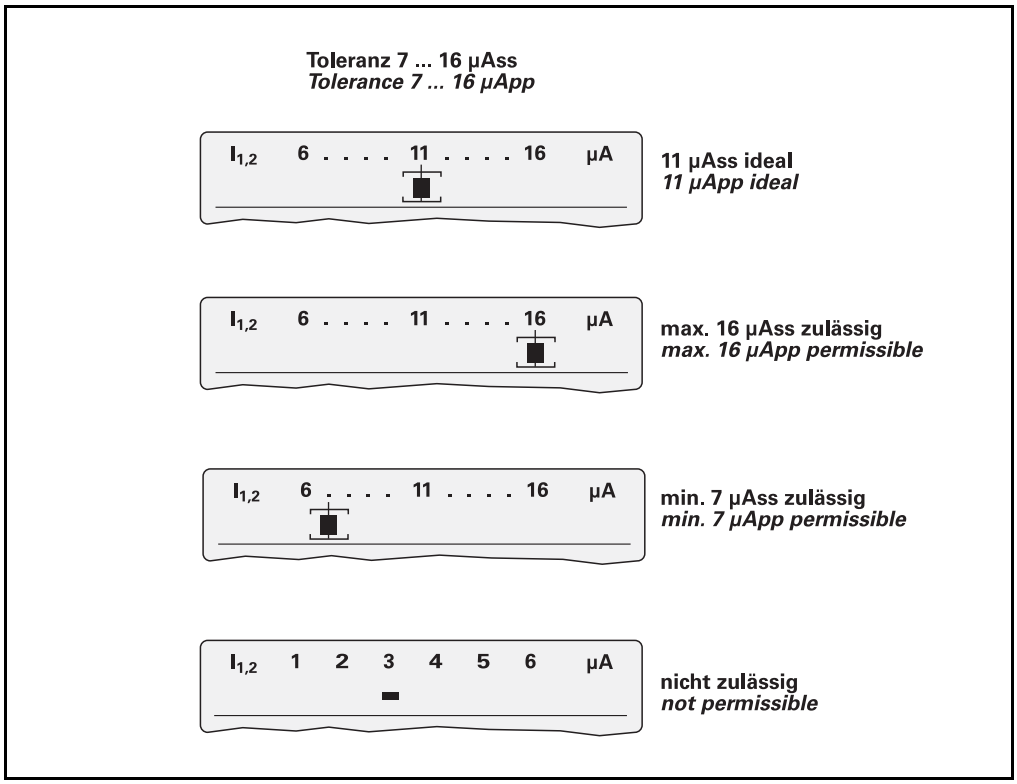
Signal amplitude



1 Vpp


Toleranz 0,6 ... 1,2 Vss
Tolerance 0.6 ... 1.2 Vpp
A,B 0.5 . . . . 1 . . . . 1.5 V
1 Vss ideal
1 Vpp ideal
A,B 0.5 . . . . 1 . . . . 1.5 V
max. 1,2 Vss zulässig
max. 1.2 Vpp permissible
A,B 0.5 . . . . 1 . . . . 1.5 V
min. 0,6 Vss zulässig
min. 0.6 Vpp permissible
A,B 0.1 0.2 0.3 0.4 0.5 0.6 V
nicht zulässig
not permissible

11 µApp


Toleranz 7 ... 16 µAss
Tolerance 7 ... 16 µApp
I1,2 6 . . . . 11 . . . . 16 µA
11 µAss ideal
11 µApp ideal
I1,2 6 . . . . 11 . . . . 16 µA
max. 16 µAss zulässig
max. 16 µApp permissible
I1,2 6 . . . . 11 . . . . 16 µA
min. 7 µAss zulässig
min. 7 µApp permissible
I1,2 1 2 3 4 5 6 µA
nicht zulässig
not permissible

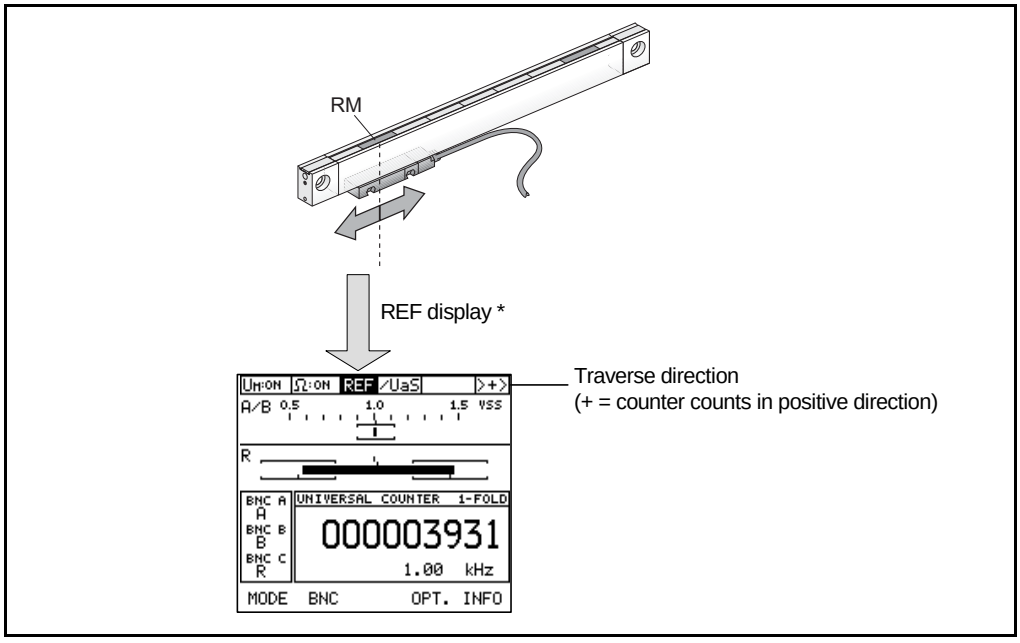
5.1.3 Checking the reference mark signal in the PWT-MODE

In the PWT-MODE the quality of the reference mark signal can be assessed.

The width and the position of the reference mark signal are measured.

Note

The reference mark (= RM) can only be tested dynamically!



* The reference mark signal is a very short electrical pulse which is displayed longer (~ 1 second).

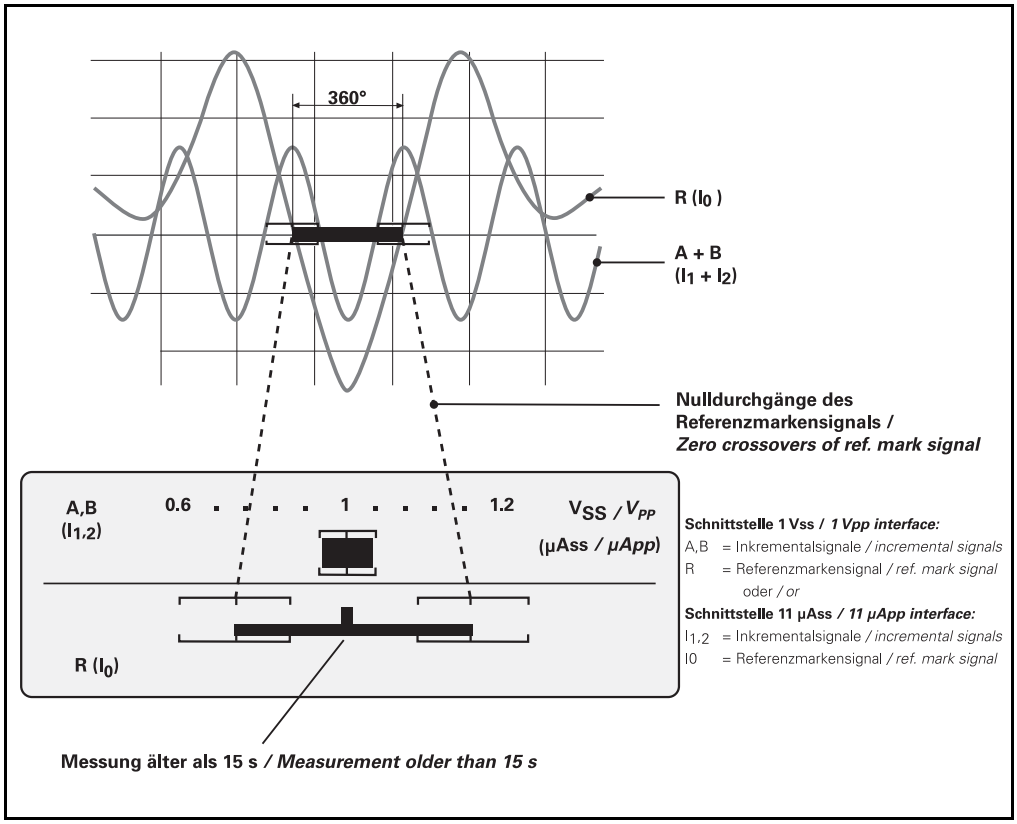
Note

The REF display in the status line does not give information on whether the reference mark signal is within the prescribed tolerance range.

The REF display serves to "search" the reference marks of measuring systems.

If you use an oscilloscope for reference mark measurement (recommended!), see the settings in chapter “Measuring the reference mark signal" on page 26!

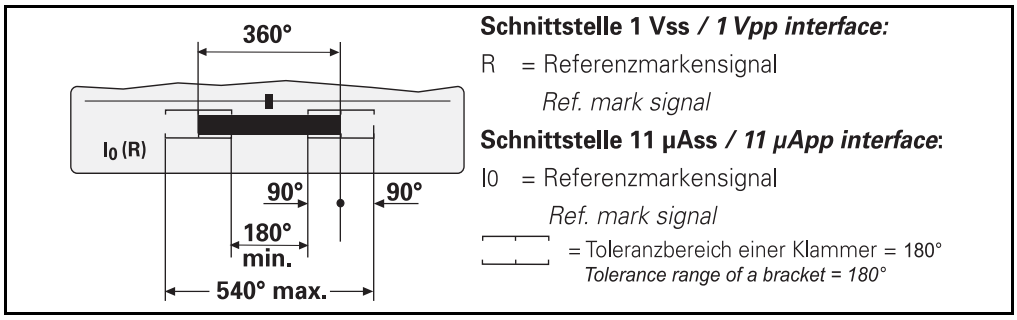
Schematic oscilloscope display (not to scale)



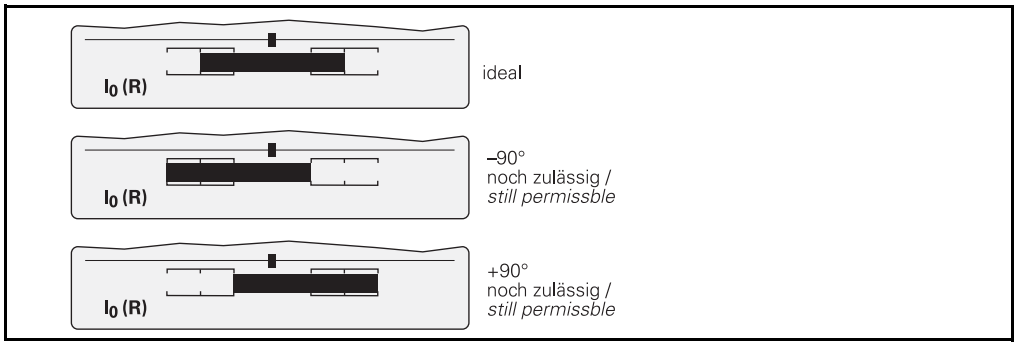
Note

For measurements that are older than 15 seconds the height of the bar halves!

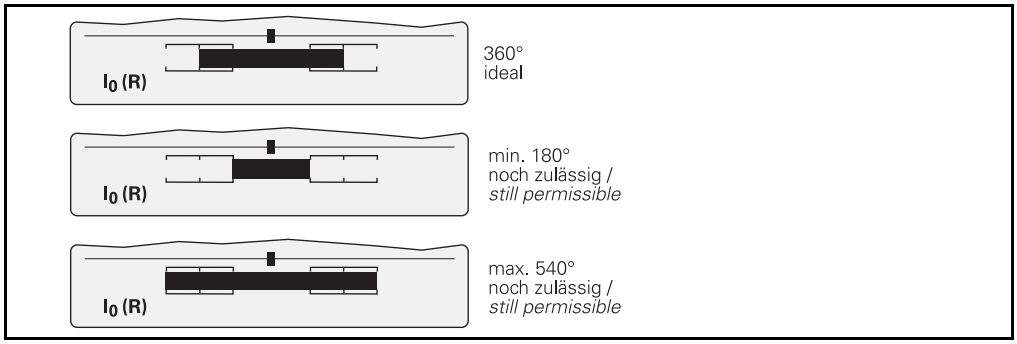
5.1.4 Tolerances for measuring the reference mark signal (examples)



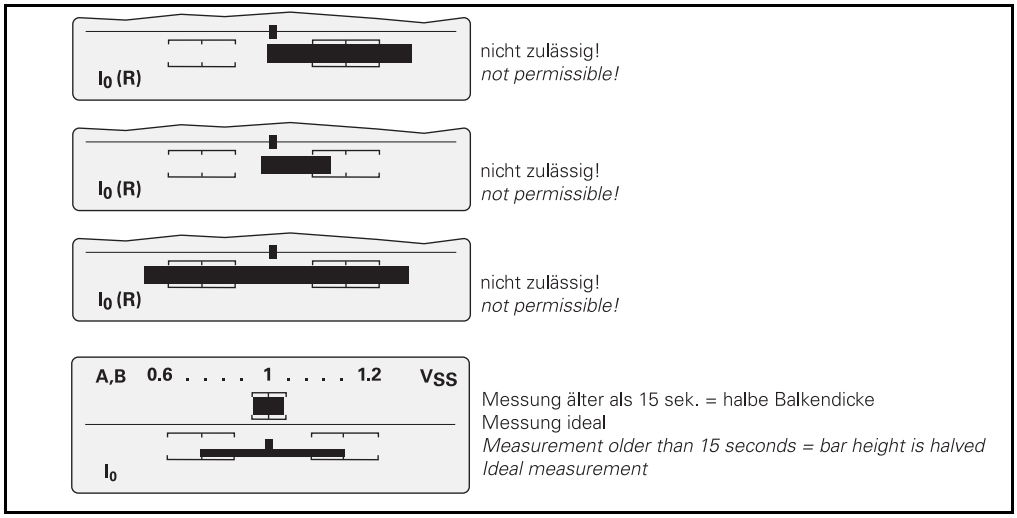
Position



Width



Tolerance exceeded



Note

The reference signal bar has to be within the tolerance brackets.
The ideal reference mark signal is 360° wide and shows no position error!

5.2 Adjustment Aid for Mounting the Scanning Head of Exposed Encoders

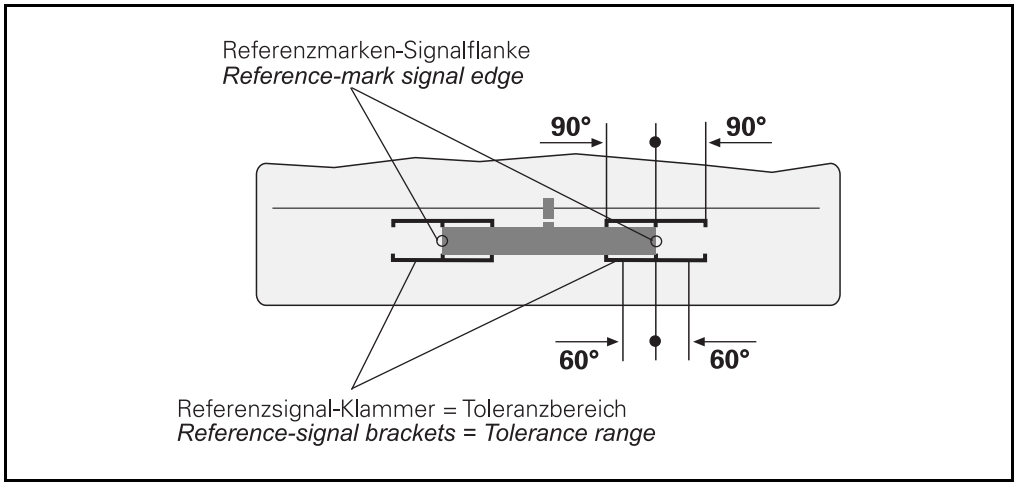
The CHECK-REF measuring function measures the reference-mark positions and widths of all reference marks traversed, and saves them in the PWM. The PWM then calculates the average reference-mark position and width deviation of all reference marks measured. Then the software checks if this deviation can be compensated for by mechanical adjustment of the scanning head. The result is displayed via the following messages:

“All reference marks optimal”
All measured reference-mark signal edges are within ± 60° in the tolerance range of the reference-signal brackets.

“Adjustment recommended”
One or more reference-mark signal edges are at the tolerance limit of the reference-signal brackets (± 90°).

“Adjustment required”
This message is generated as soon as a reference-mark signal edge is outside the tolerance limit of the reference-signal brackets (> ± 90°).

“Adjustment not possible”
The reference-mark signal edges are outside of the area that can be compensated mechanically. Reliable operation of the reference signal is not ensured.
Exchange the scale or scanning head and repeat the measurement.



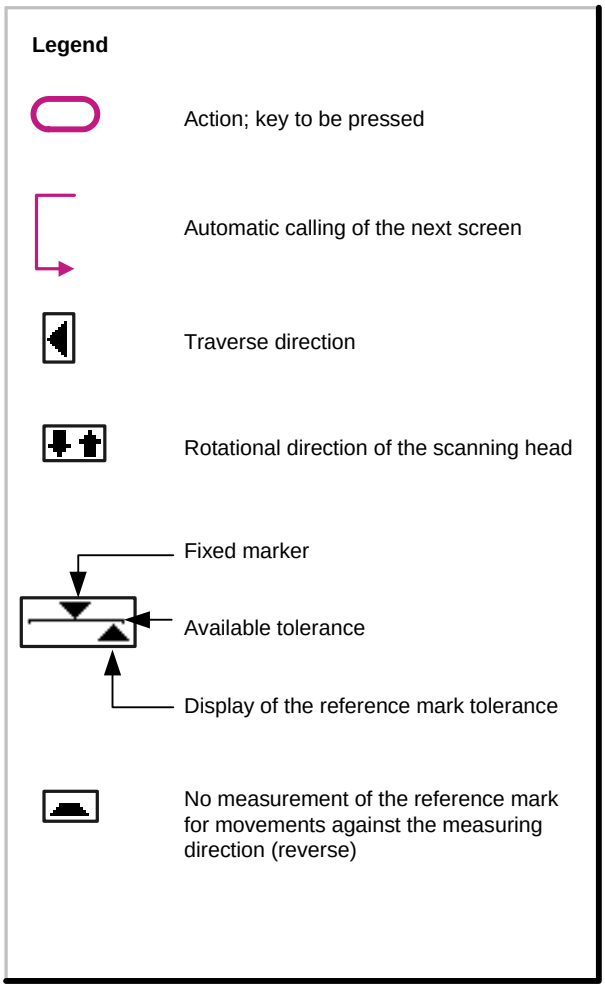
5.2.1 Preparations

To obtain correct measuring results the order of instructions has to be adhered to.

Maintaining the mounting dimensions of the encoder is a prerequisite for the measurement!

The measuring procedure is as follows:

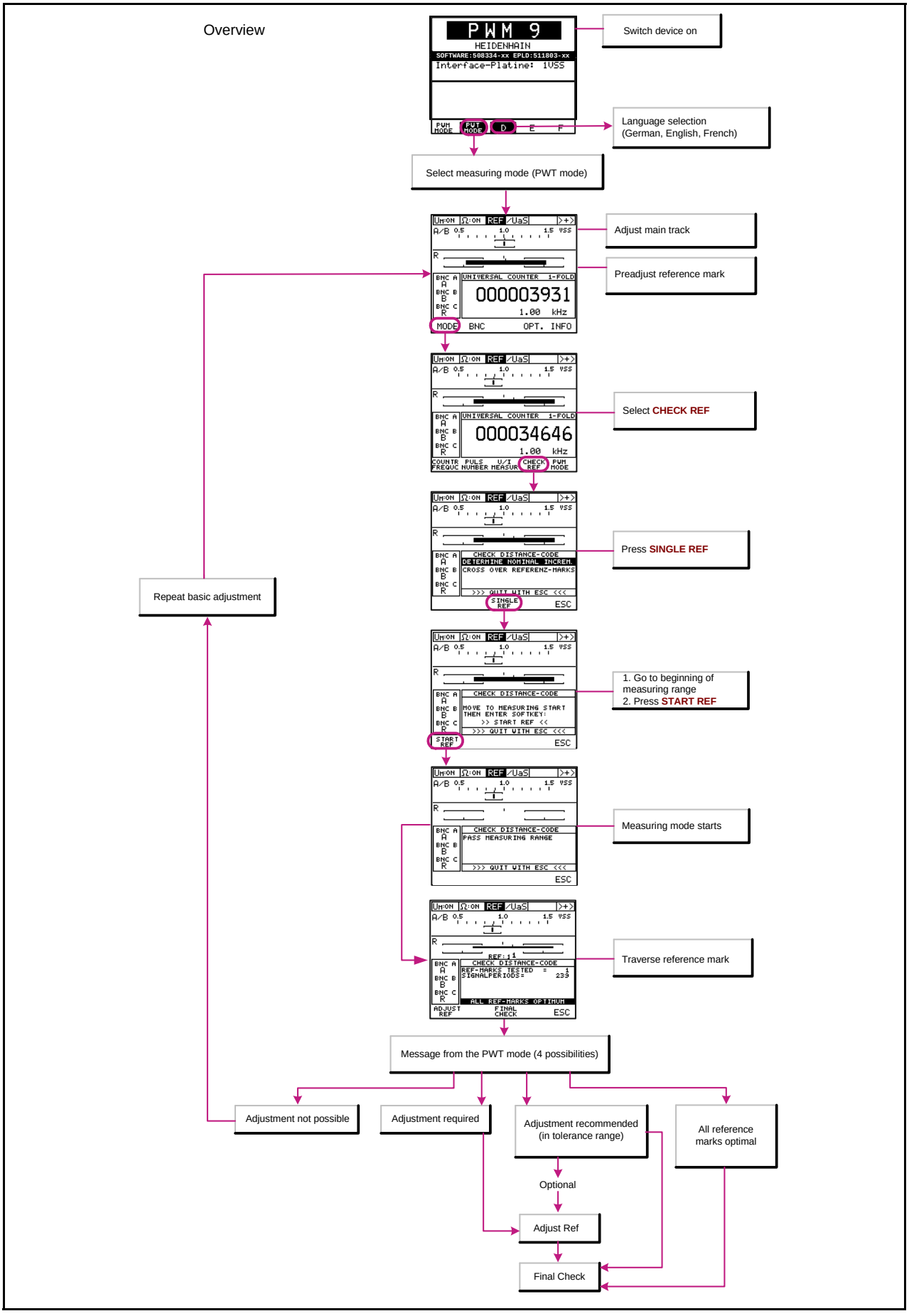
- Beginning of measurement
- Basic adjustment
- Measurement: One reference mark
- Measurement: Multiple reference marks
- Messages in the PWT-MODE:
  - "All reference marks optimal"
  - "Adjustment recommended " (in tolerance range)
  - "Adjustment required " – precision adjustment
  - "Adjustment not possible"


Legend
Action; key to be pressed
Automatic calling of the next screen
Traverse direction
Rotational direction of the scanning head
Fixed marker
Available tolerance
Display of the reference mark tolerance
No measurement of the reference mark for movements against the measuring direction (reverse)

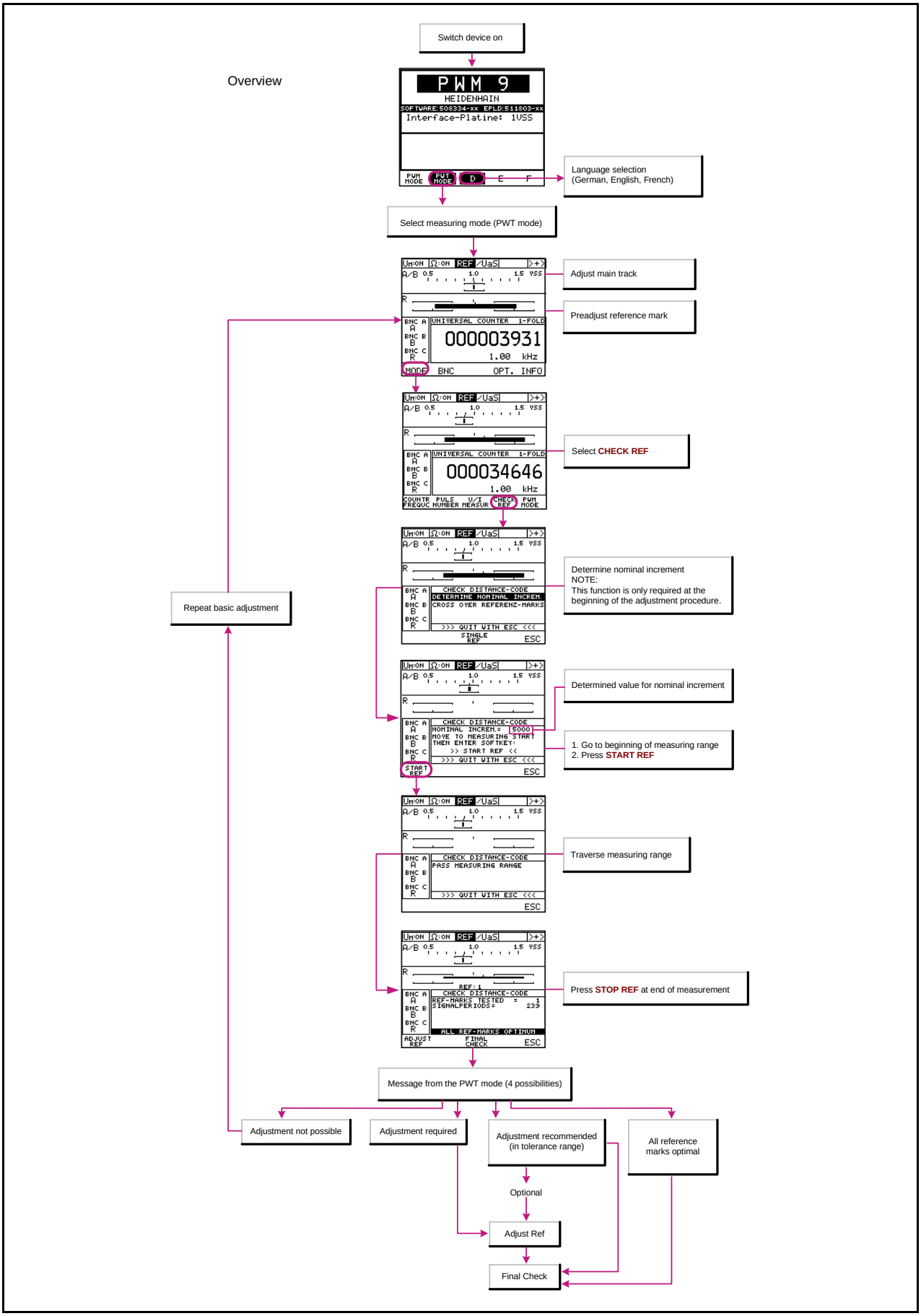
Note

The measuring procedure differs with the number of reference marks:
- Measurement with **one** reference mark
- Measurement with **multiple** reference marks

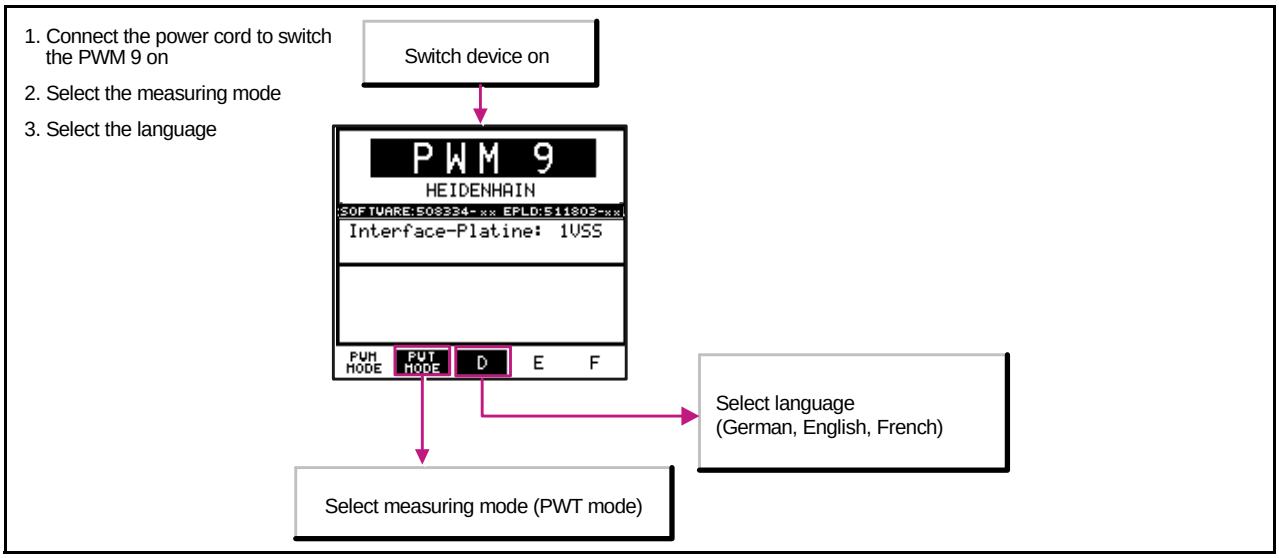
Measurement with one reference mark



Measurement with multiple reference marks



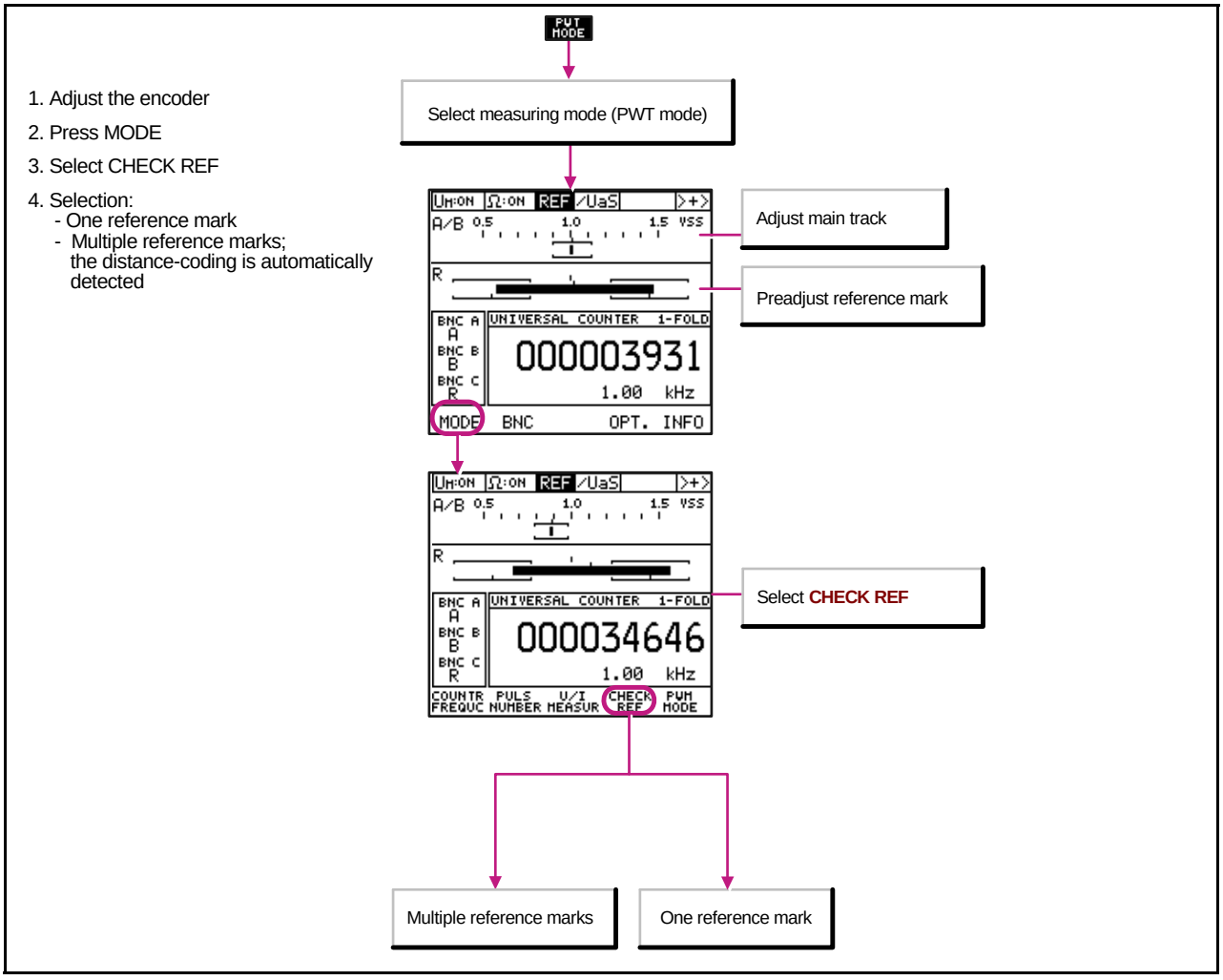
5.2.2 Beginning of measurement



5.2.3 Basic adjustment

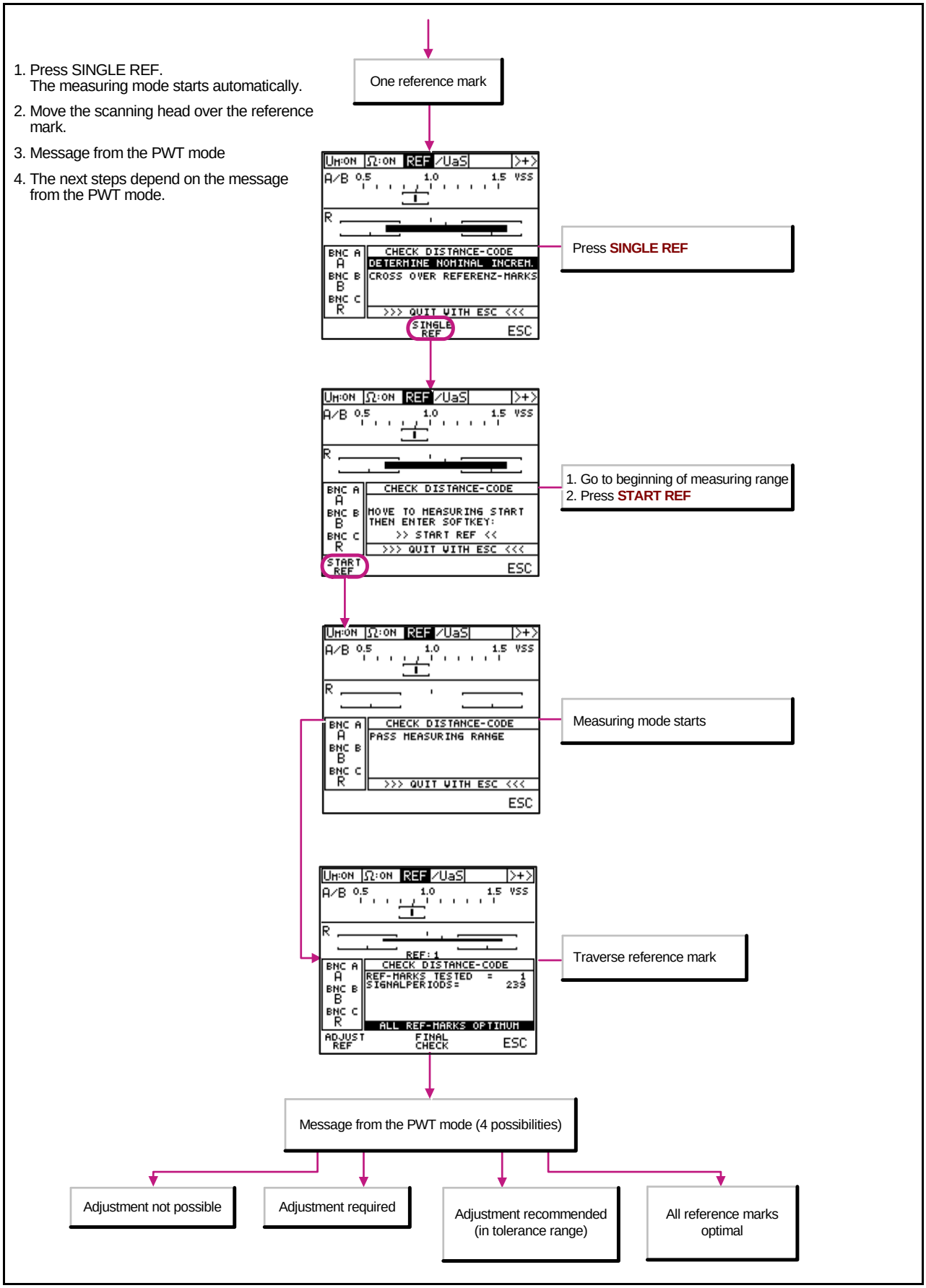
Note

For a detailed description on adjusting the main track refer to the instructions of your measuring system.



5.2.4 Measurement: One reference mark

1. Press SINGLE REF.
   The measuring mode starts automatically.
2. Move the scanning head over the reference mark.
3. Message from the PWT mode
4. The next steps depend on the message from the PWT mode.

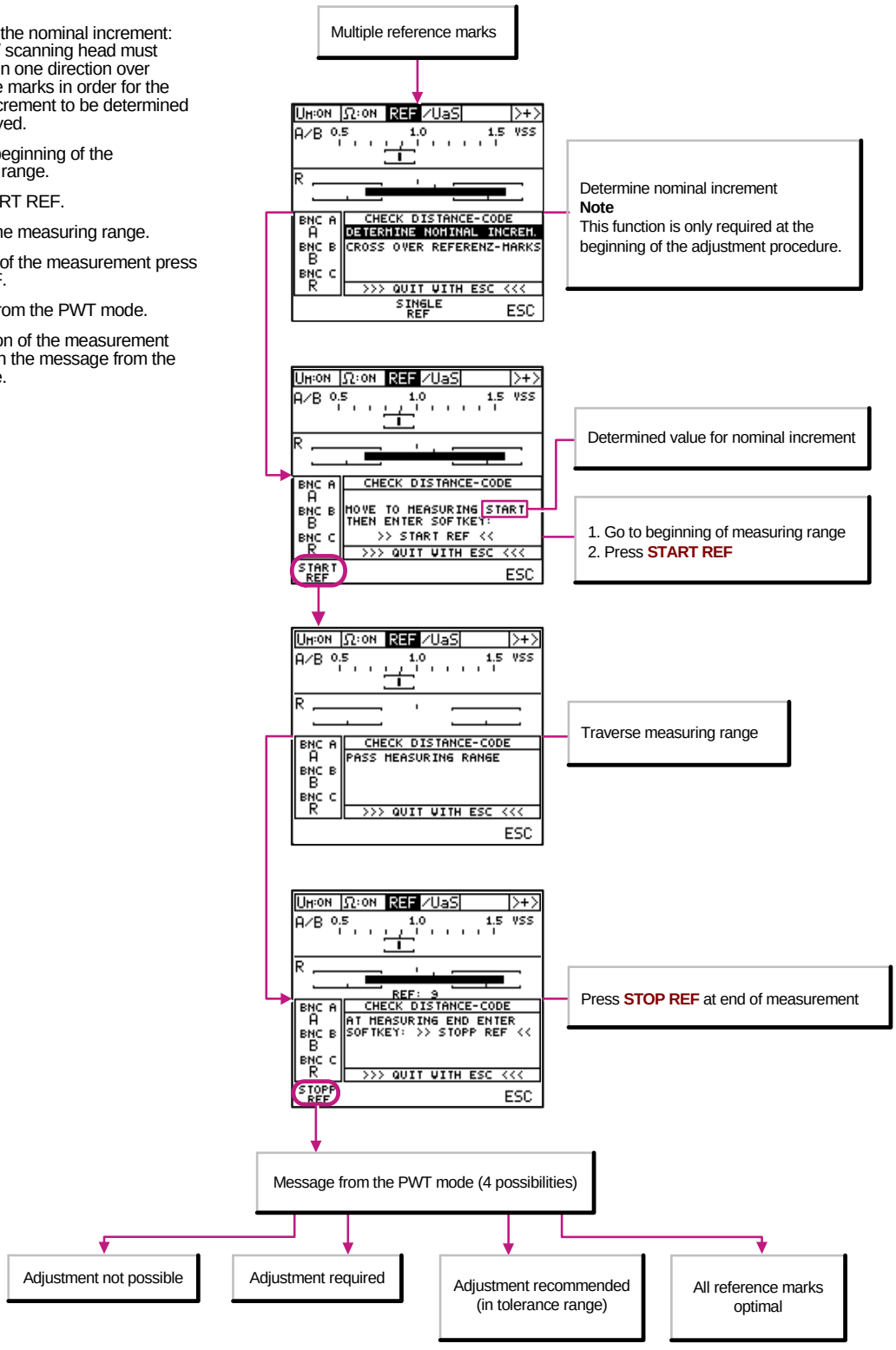


5.2.5 Measurement: Multiple reference marks

Note

Move the scale or the scanning head in one direction only. The message "WRONG DIRECTION" may be generated when the scale or scanning head are in standstill. This message can be ignored, since absolute standstill without change of traversing direction is hardly possible when the scanning head is traversed by hand.

1. Determine the nominal increment: The scale / scanning head must be moved in one direction over 5 reference marks in order for the nominal increment to be determined and displayed.
2. Go to the beginning of the measuring range.
3. Press START REF.
4. Traverse the measuring range.
5. At the end of the measurement press STOP REF.
6. Message from the PWT mode.
7. Continuation of the measurement depends on the message from the PWT mode.


Multiple reference marks
Determine nominal increment
Note
This function is only required at the beginning of the adjustment procedure.
Determined value for nominal increment
1. Go to beginning of measuring range
2. Press START REF
Traverse measuring range
Press STOP REF at end of measurement
Message from the PWT mode (4 possibilities)
Adjustment not possible
Adjustment required
Adjustment recommended (in tolerance range)
All reference marks optimal

Note

The error message **Distance-code connection** is generated when the first reference mark of an angle encoder with distance-coded reference marks (e.g. ROD 780C, "C" stands for "distance-coded reference marks") is traversed.

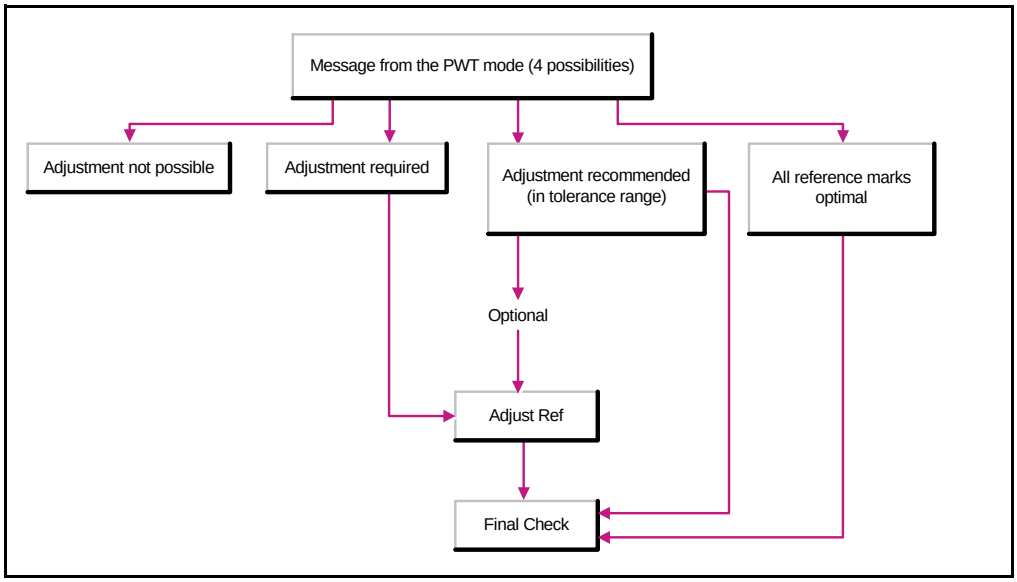
The 1st distance-coded reference mark of rotary encoders is marked; on angle encoders with scale tapes (e.g. ERA) it is located at the butt joints.

The message "NOMINAL INCREMENT ERROR" is displayed when the nominal increment is determined, if the traversing speed is too high or if the reference mark with the first distance coding is traversed.

5.2.6 Messages in the PWT-MODE

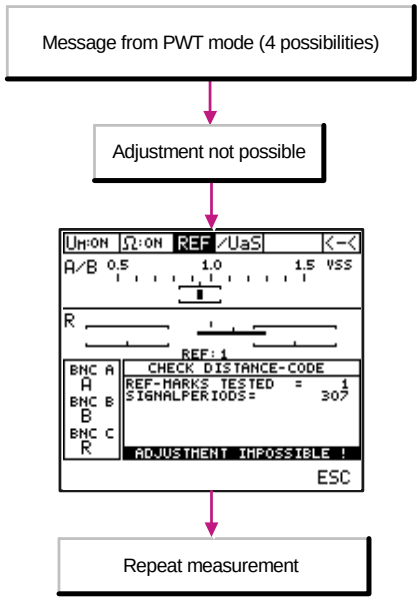
There are four different messages:

- ADJUSTMENT IMPOSSIBLE
- ADJUSTMENT REQUIRED
- ADJUSTMENT RECOMMENDED (the signals are **still** in the tolerance range)
- ALL REFERENCE MARKS OPTIMAL



Message:
ADJUSTMENT IMPOSSIBLE

1. Repeat the basic adjustment
   and read the section
   “Errors during measurement" on page 47.
2. If the message
   ADJUSTMENT NOT POSSIBLE
   is generated again, check the mounting
   tolerances.



Message: ADJUSTMENT REQUIRED

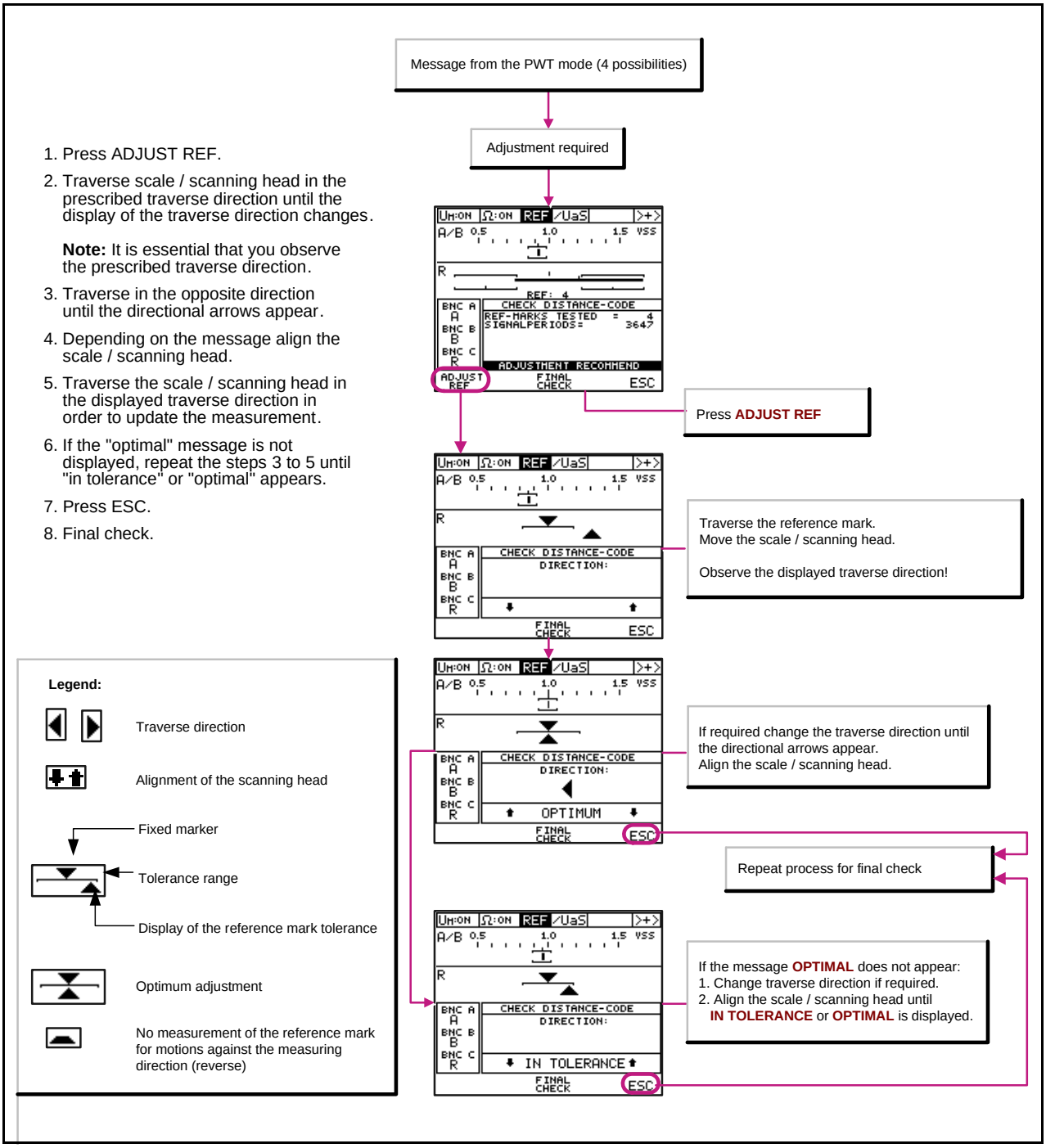
When this message is displayed, scale and scanning head require precision adjustment.

Attention

The precision adjustment of scale and scanning head may influence and alter the defined basic adjustment. In this event you will have to repeat the entire measurement.

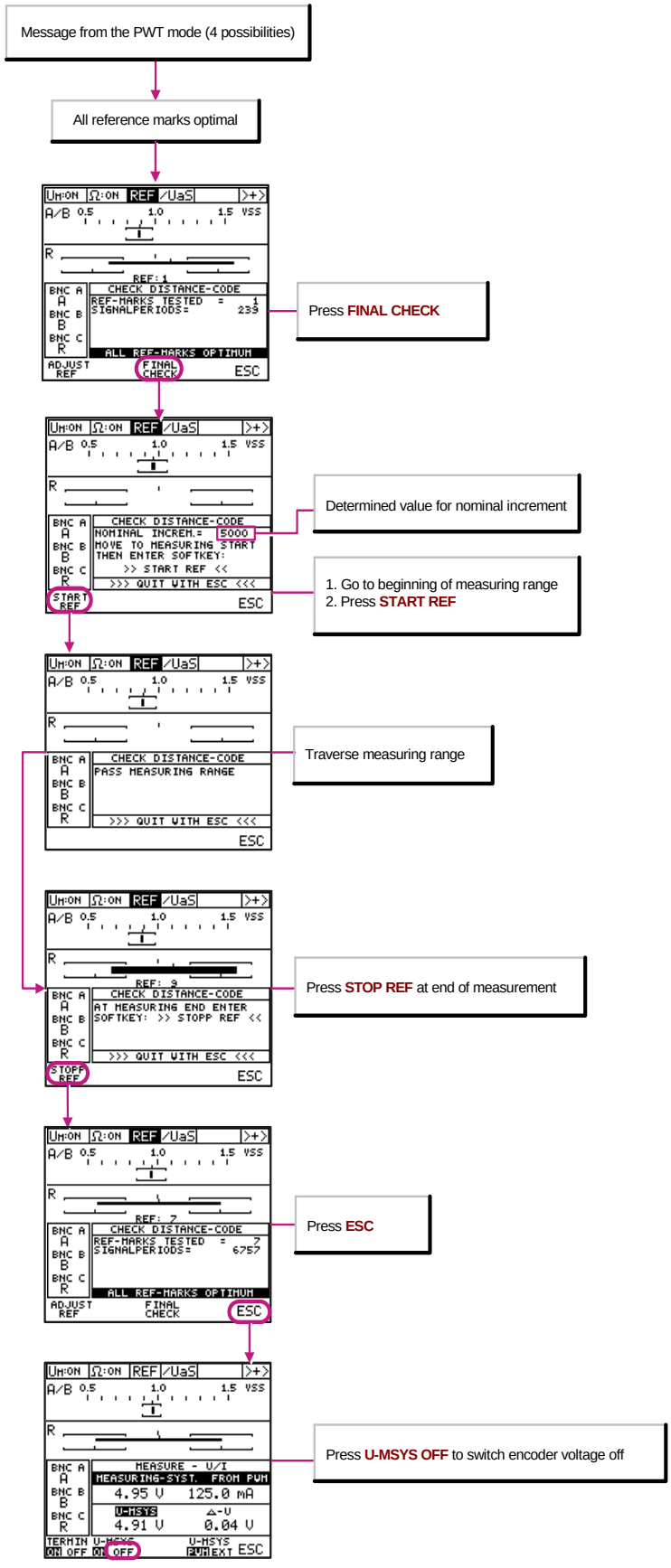
1. Press ADJUST REF.
2. Traverse scale / scanning head in the prescribed traverse direction until the display of the traverse direction changes.

   Note: It is essential that you observe the prescribed traverse direction.
3. Traverse in the opposite direction until the directional arrows appear.
4. Depending on the message align the scale / scanning head.
5. Traverse the scale / scanning head in the displayed traverse direction in order to update the measurement.
6. If the "optimal" message is not displayed, repeat the steps 3 to 5 until "in tolerance" or "optimal" appears.
7. Press ESC.
8. Final check.


Message from the PWT mode (4 possibilities)
Adjustment required
Press ADJUST REF
Traverse the reference mark.
Move the scale / scanning head.
Observe the displayed traverse direction!
If required change the traverse direction until the directional arrows appear.
Align the scale / scanning head.
Repeat process for final check
If the message OPTIMAL does not appear:
1. Change traverse direction if required.
2. Align the scale / scanning head until IN TOLERANCE or OPTIMAL is displayed.
Legend:
Traverse direction
Alignment of the scanning head
Fixed marker
Tolerance range
Display of the reference mark tolerance
Optimum adjustment
No measurement of the reference mark for motions against the measuring direction (reverse)

Message:
ALL REFERENCE MARKS OPTIMAL or ADJUSTMENT RECOMMENDED (in tolerance range)
The procedure is the same for both messages.

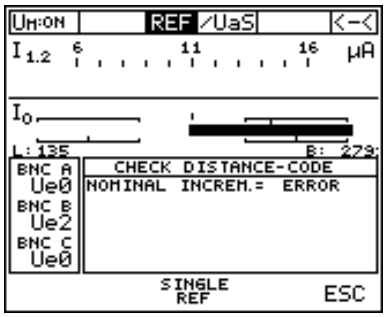
1. Secure the scale/scanning head after the measurement. The mounting instructions of the encoder include detailed instructions for this.
2. Press FINAL CHECK.
3. Go to the beginning of the measuring range.
4. Press START REF.
5. Traverse the measuring range.
6. At the end of the measuring range press STOP REF.
7. The message “All reference marks optimal“ appears. If “Adjustment required“ is displayed you will have to perform a precision adjustment of the scale or the scanning head.
8. Press ESC.
9. Press U-MSYS OFF to switch the encoder voltage off.


Message from the PWT mode (4 possibilities)
All reference marks optimal
Press FINAL CHECK
Determined value for nominal increment
1. Go to beginning of measuring range
2. Press START REF
Traverse measuring range
Press STOP REF at end of measurement
Press ESC
Press U-MSYS OFF to switch encoder voltage off

5.2.7 Errors during measurement

Error on finding the nominal increment

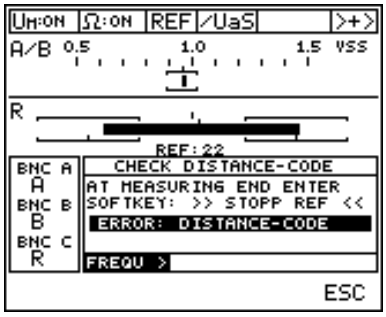
1. Repeat the basic adjustment.
2. If the message "NOMINAL INCREM. ERROR" is generated, check the mounting tolerances.
3. If you are still unable to determine the nominal increment, contact the HEIDENHAIN service.



Error on checking the distance-coding or on finding the average position and width of the ref. marks

If the traverse rate is too high,
"FREQU >" and/or
"ERROR: DISTANCE CODE" are displayed:

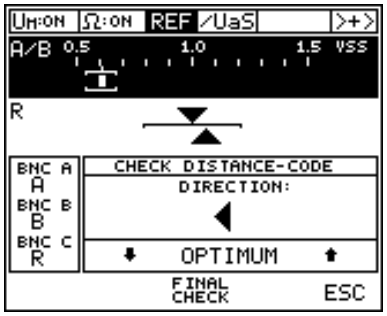
1. Press ESC
2. Press MODE
3. Select CHECK REF
4. Press START REF
5. Traverse slowly and at constant speed



Signal amplitude error

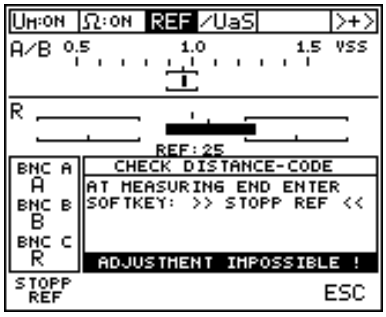
Signal amplitude below minimum when turning scale or scanning head.

Turn scale or scanning head such that the signal amplitude is within the tolerance range.



Faulty mechanical mounting

If the error message
ADJUSTMENT IMPOSSIBLE
is displayed, check the mechanical mounting (mounting tolerances) and repeat the adjustment.



Further operation impossible (software crash)

1. Press ESC
2. Repeat the entire measurement.

OR:

1. Switch the unit off and on.
2. Repeat the entire measurement.

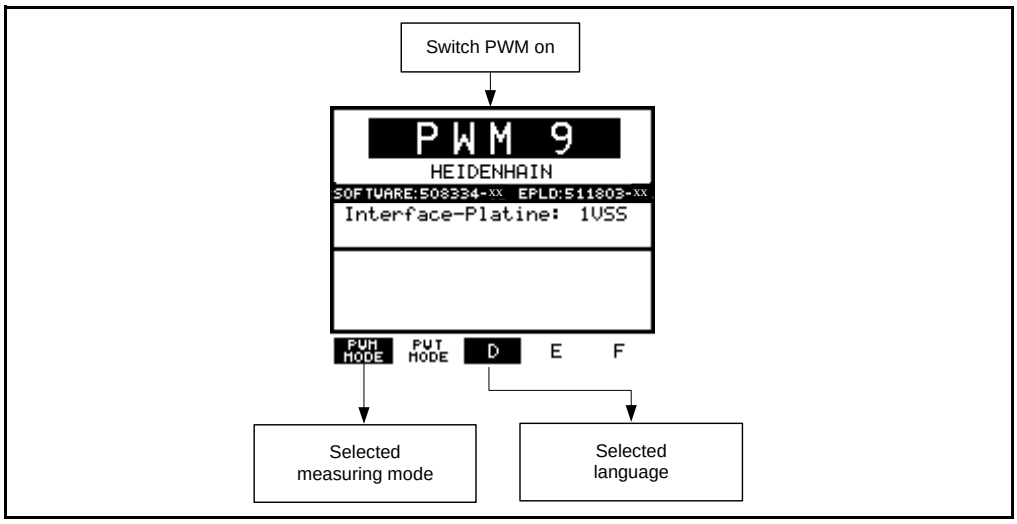
5.3 Measuring in the PWM MODE

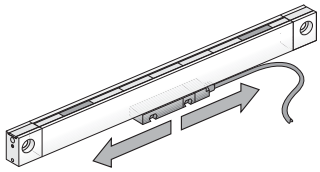
Note

For measuring setup, MODE setting and oscilloscope setting see the respective chapters of this manual.

In the example below the 1 Vpp output signals of a measuring system are checked. The 1 Vpp interface board is inserted! The measuring system to be checked is connected as described in the measuring setup section.

Active functions are displayed inversely (dark).

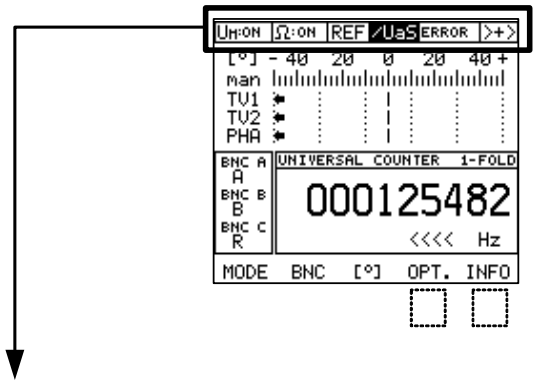




Messgerät oder Maschinenachse verfahren!
Traverse measuring system or machine axis!

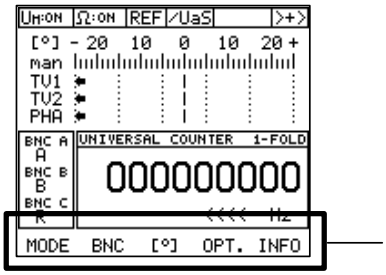
5.3.1 Description of the PWM MODE display

Status display



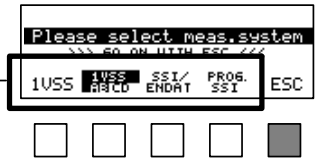
UM: ON	The supply voltage of the measuring system is on (press OPT soft key to change setting.)
UM: OFF	The supply voltage of the measuring system is off (press OPT soft key to change setting.)
Ω: ON	Terminating resistor switched on; setting depends on interface board (press OPT soft key to change setting.)
Ω: OFF	Terminating resistor switched off (press OPT soft key to change setting.)
REF	No reference signal
REF	Reference signal detected (no real-time display; duration of display: approx. 1 second)
/UaS	No fault-detection signal
/UaS **ERROR**	The fault-detection signal signalizes that the encoder output level is below its functional limit (ERROR fault detection signal is stored).
/UaS	If /UaS remains "dark", there may be two different causes: 1. Signal error (see /UaS ERROR) 2. The encoder does not support /UaS! The signal pin is not connected; this is interpreted as error (low active). **Exception:** In some encoders that do not support the fault detection signal, the /UaS pin is connected to +5 V! /UaS **always** indicates "No fault detection signal"! **Note:** Observe the mounting instructions of the encoder!
/UaS ERROR	No fault detection signal, but fault detection bit (ERROR) set by a previous fault. The ERROR can be cleared by: 1. Calling a new PWM MODE 2. Pressing the soft key INFO "CLR ERROR"
> + >	Positive counting direction
< - <	Negative counting direction

5.3.2 Description of the soft-key row



Standard soft-key row for calling the menus for settings and functions

Soft-key row when multi-purpose interface board absolute / 1 Vpp, ID 312 186-02 is inserted



After the power-on screen the encoder interface to be tested has to be selected.
In this example a 1Vpp encoder with AB and CD output signals was selected (rotary encoder with commutating signals, e.g. ERN 1387).

■ Select by soft key and confirm with ESC

1 Vpp	1 Vpp interface, "standard"
1 Vpp AB	Encoder with sinusoidal commutating track (Zn/Z1) Incremental track AB (= Zn) e.g. ERN 1387 2048 sinusoidal signals/rev.
1 Vpp CD	CD commutating track (= Z1) e.g. ERN 1387 1 sine and cosine signals/rev.
SSI/ ENDAT	Encoder with EnDat or SSI interface (same functional test)
PROG. SSI	Encoder with programmed SSI interface (SSI 09 and SSI 10 with operating voltage 10 - 30 V)

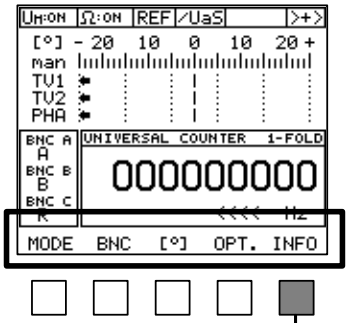
Note

With absolute encoders only the incremental signals are measured. The PWM cannot evaluate absolute output signals.

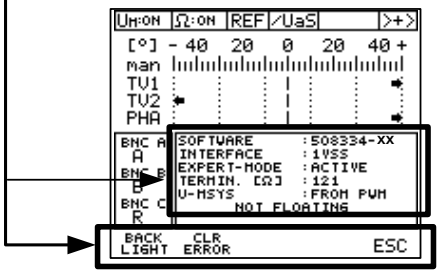
Via the BNC outputs the absolute data signals can be viewed on an oscilloscope (only possible, if the encoder is operated with a subsequent electronics).

For absolute output signals HEIDENHAIN offers special computer interface cards for diagnosing.

5.3.3 Description of the INFO soft key

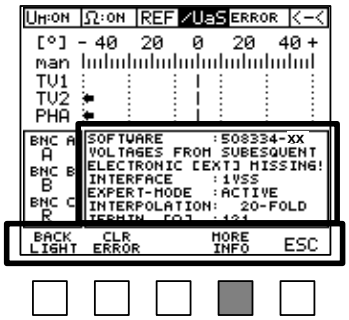


Press ESC to return to the standard soft-key row



Example 1

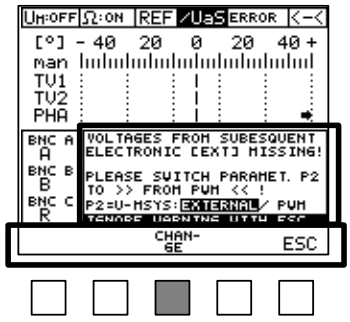
- PWM software number
- 1Vpp interface board
- Terminating resistor 121 ohms
- Encoder supply: from PWM, floating



Example 2

- 20-fold interpolation
- Encoder supply: from subsequent electronics

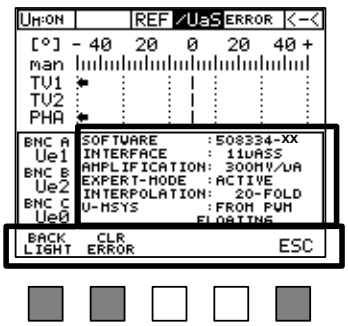
■ Press MORE INFO
(to switch to the next INFO screen)



Example 3

- The encoder power supply is set to 'subsequent electronics' (EXTERNAL), but no voltage is detected coming from the subsequent electronics. To check the encoder the device must be switched to 'from PWM'.

■ Press CHANGE = from PWM



Example 4

- 11 µApp interface board
- Signal amplification 300 $\frac{mV}{mA}$

■ Press BACK LIGHT (back light on or off)
■ Press CLR ERROR (clears /UaS ERROR in status display)
■ Press ESC (closes the INFO screen)

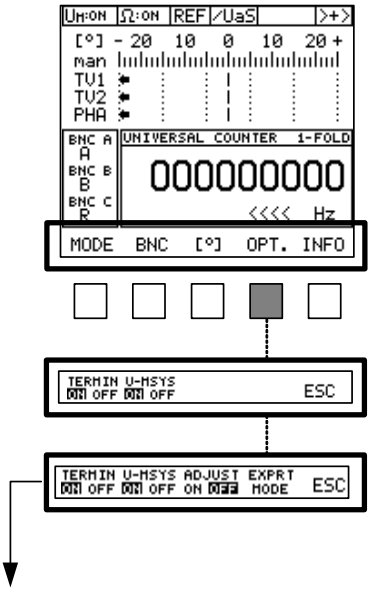
5.3.4 Description of the OPT soft key (options)

Note

PWM settings are made in the Options mode.

DANGER

Do not change the encoder voltages **U-MSYS** and supply voltages **ADJUST**, if the PWM is operated in the active position control loop!



- Activation of the OPTIONS soft-key row

Possible functions:

Soft-key row when EXPERT MODE is not active

Soft-key row when EXPERT MODE is active

TERMIN ON OFF	The terminating resistors for the scanning signals can be switched ON and OFF (only with TTL, HTL or 1 Vpp interface board). The current setting is stored in the PWM and reloaded after power interruption!

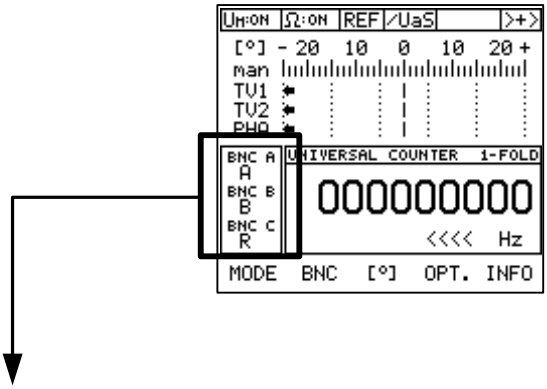
Interface board	**Terminating resistor [Ω]**		
	0 V	**+U Encoder**	**Selectable**
TTL	91	215	yes
HTL	1200	1200	yes
1 Vpp	121		yes
11 µApp	-	-	-
Absolute/1 Vpp	121 (Zn), 1000 (Z1)		no

U-MSYS ON OFF	The encoder operating voltage can be switched ON or OFF.
ADJUST ON OFF	Display only in active EXPERT MODE and if parameter P2 (U-MSYS) is set to "EXTERNAL".
EXPRT MODE	Display only in active EXPERT MODE; see "Activating the EXPERT MODE" on page 100 and "EXPERT MODE" on page 73.
ESC	Terminates the "**Opt**ions"

Note

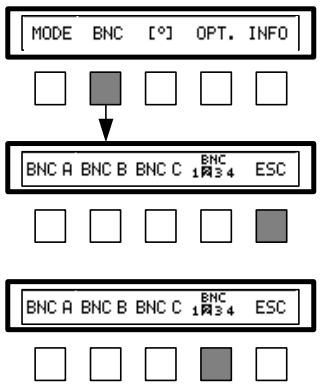
The inverse display shows the active status.

5.3.5 Assignment of the BNC sockets



BNC A **A** **BNC B** **B** **BNC C** **R**	Display of the current assignment of the BNC sockets A, B and C Example: Incremental signal 1 Vpp, A signal (= 0°) on BNC socket A; B signal (= 90°) on socket B; can be viewed on an oscilloscope.

5.3.6 Changing the BNC sockets and memory assignment



- Closes the BNC menu
- BNC memories:
  Each of the **4 BNC memories** can be assigned individually.

Example of memory assignment

Memory 1

Measure incremental signal

Memory 2

Measure ref. mark signal

Note

The selected memory (1, 2, 3, 4) contains the most recent setting of the BNC assignment. Each keystroke activates the next memory. The inversely displayed memory is active!

Note

The data is stored on the interface board.

5.3.7 Possible assignments of the BNC sockets

Note

The BNC assignment depends on the interface board!

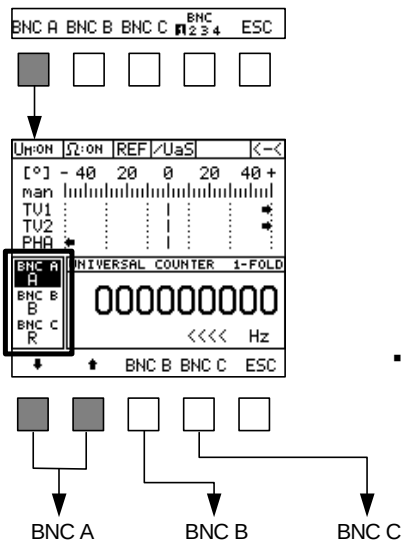
Note

Using the BNC sockets

- When using the BNC sockets for measuring encoder signals with an oscilloscope, the operator has to arrange for the necessary ESD precautions.
- A floating oscilloscope or an isolating transformer should be used to ensure that the display of the encoder signals is as interference-free as possible.
  Always use the connector of the electrical cabinet of the machine to power the oscilloscope.
  This avoids signal distortions which may result from different ground potentials.

Note

The assignment of the BNC sockets is stored on the interface board.



Example:
BNC socket A to be altered

- Press the arrow keys to 'scan' to the desired BNC signal.

Possible signals: see table (factory setting)

The bold signals are the factory default settings for the respective memory locations (1 … 4). To restore this status use the "Factory Default" function (see "Restoring the Factory Setting" on page 100).

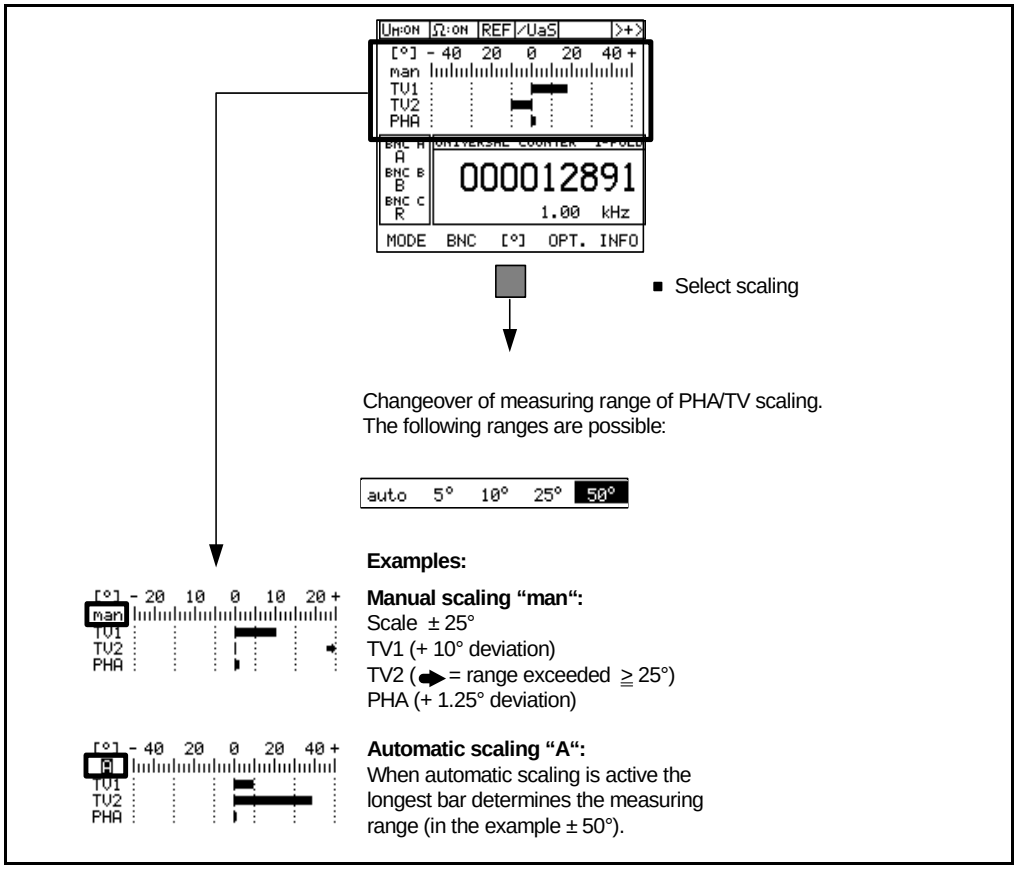
Selectable encoder signals			BNC memory assignment[3]	Output signals	Interface board
BNC A	**BNC B**	**BNC C**			
Ue1 **Ue0** **Ue1** **Ue0** Ue2 Ue1 + Ue2	**Ue2** **Ue1 + Ue2** **Ue2** **Ue0** Ue1	**Ue0** **UP** **UP** **/UaS** [1] 	**1** **2** **3** **4** **Possible signals**	Incremental signals ~ 11 µApp	**11 µApp** ID 323083-01
A **R** **A** **R** B A + B	**B** **A + B** **B** **R** A	**R** **UP** **UP** **/UaS** [1] 	**1** **2** **3** **4** **Possible signals**	Incremental signals A / B ~ 1 Vpp	**1 Vpp** ID 323077-02
C **R** **C** **R** **D** **C + D**	**D** **C + D** **D** **R** C	**R** [2] **UP** **UP** **/UaS** [1] 	**1** **2** **3** **4** **Possible signals**	Commutating signals C, D ~ 1 Vpp	**absolute / 1 Vpp** ID 312186-02
A **CLK+** **CLK-** **DAT+** DAT- B	**B** **DAT+** **DAT-** CLK+ CLK- A	**UP** **/UaS** [1] **UP** **/UaS** [1] CLK+ CLK-	**1** **2** **3** **4** **Possible signals**	Incremental signals ~ 1 Vpp Absolute signals ⊓⊔ EnDat / SSI	**absolute/1 Vpp** ID 312186-02
Ua1 **/Ua1** **Ua0** **Ua1** Ua2 /Ua2 /Ua0	**Ua2** **/Ua2** **/Ua0** **/Ua1** Ua1 Ua0	**Ua0** **/Ua0** **UP** **/UaS**	**1** **2** **3** **4** **Possible signals**	Incremental signals ⊓⊔ TTL	**TTL** ID 323079-01
Ua1 **/Ua1** **Ua0** **Ua1** Ua2 /Ua2 /Ua0	**Ua2** **/Ua2** **/Ua0** **/Ua1** Ua1 Ua0	**Ua0** **/Ua0** **UP** **/UaS**	**1** **2** **3** **4** **Possible signals**	Incremental signals ⊓⊔ HTL	**HTL** ID 322732-01

[1] Signal is not an encoder signal, but is generated on the interface board
[2] Signal related to AB-track of encoder
[3] Factory default setting (bold) can be altered according to your requirements

5.3.8 Display of on-to-off ratio and phase shift

Note

Display of the tolerances for on-to-off ratio **1** (**TV1** signal = 0° signal), on-to-off ratio **2** (**TV2** signal = 90° signal) and **PHA**se shift between the two incremental signals (**PHA**).



Note

Tolerances for on-to-off ratio and phase angle: see “Interface Description" on page 115!

Attention

Always observe the tolerances specified in the original mounting instructions of the encoder to be tested.

Definition

TV1/TV2

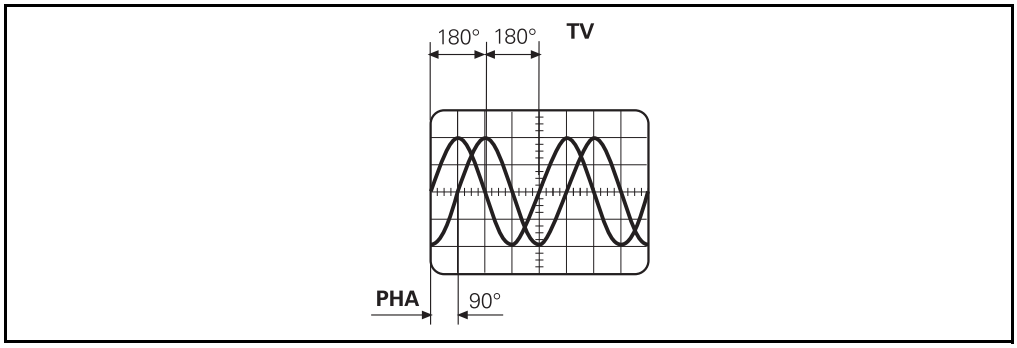
On-to-off ratio of incremental signal 1, incremental signal 2

Analog incremental signals are triggered at zero crossover, i.e. they are converted into square-wave signals.
A period (= high time plus low time of the square-wave signal) is subdivided into 360°.
If high time and low time of the square-wave signal are the same (ideal case), i.e. 180° each (180° + 180° = 360°), the on-to-off ratio is 0°.
If the high time of the square-wave signal is longer than the low time, one speaks of a positive on-to-off ratio.
An on-to-off ratio of e.g. + 10° means that the high time of the square-wave signal is 190° (180° + 10°) and its low time 170° (180° - 10°).

PHA

Phase shift of incremental signal 1 and incremental signal 2.

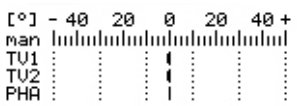
If the incremental signal 1 is by 90° ahead of the incremental signal 2, one speaks of a 0° phase shift (ideal case). Differences from the optimum phase shift of 90° are indicated as phase-shift error (in degrees).



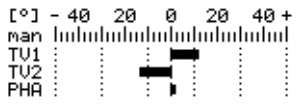
PHA/TV display

PHA and TV are displayed as bars. The scaling of the PHA/TV display can be adapted to different measuring ranges.
Settings are made via the [°] soft key.
With automatic changeover of the measuring range, the range (in degrees) of the PHA/TV display is automatically adapted to the biggest error (longest bar).

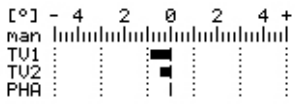
Examples of PHA/TV displays



Scaling ± 50°
(1 graduation line ≙ 2.5°)
TV1, TV2 = below - 2.5°
PHA = 0°



Scaling ± 50°
(1 graduation line ≙ 2.5°)
TV1 = + 12.5°
TV2 = - 15°
PHA = + 2.5°



Scaling ± 5°
(1 graduation line ≙ 0.25°!)
TV1 = - 0.75°
TV2 = - 0.5°
PHA = 0°

For the permissible signal tolerances please refer to the mounting instructions of your measuring system or to chapter "Interface Description" on page 115 of this manual.

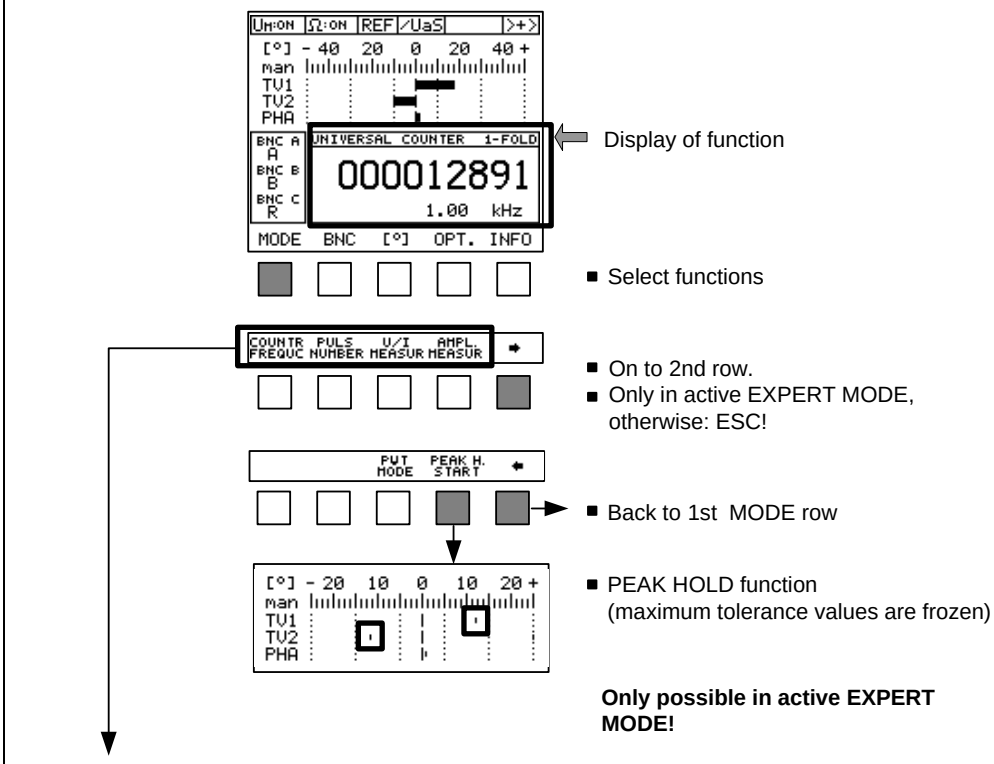
Note

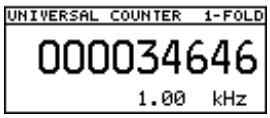
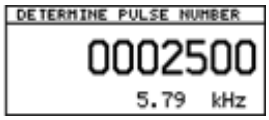
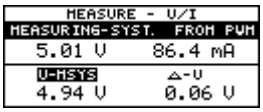
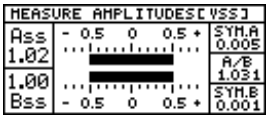
If the output signals are ideal, the displayed bars are small.
The width of the bars also depends on the scaling!

5.3.9 MODE display

Note

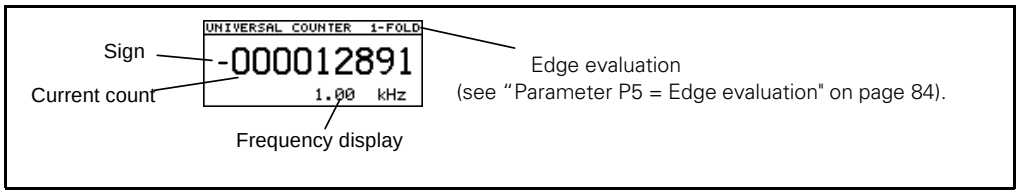
MODE leads you to the functions of encoder diagnosis.



COUNTR FREQUC		UNIVERSAL COUNTER and frequency measurement
PULSE NUMBER		Determine pulse number (e.g. count the graduation lines of a rotary encoder) Test of counting function
MEASURE U/I		Measure U/I (measure operating voltage and current consumption)
MEASURE AMPL.		Measure signal amplitudes (measure amplitudes of output signal)

5.3.10 UNIVERSAL COUNTER MODE

The UNIVERSAL COUNTER counts the interpolated or triggered incremental signals (depending on the interface board).

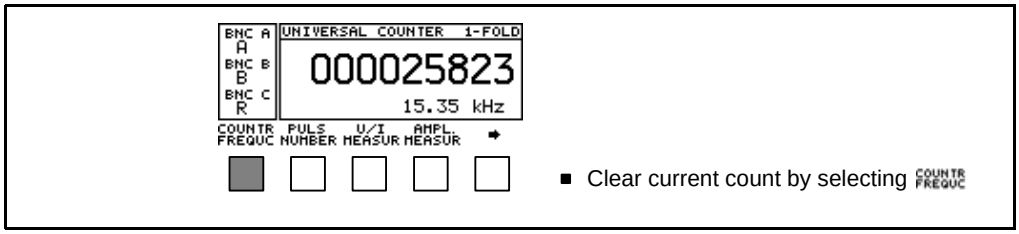


Note

The functionality of the UNIVERSAL COUNTER can be adapted by means of the counter parameters (see "Parameter P6 = Set INTERPOLATION" on page 86.)

- 1-fold to 1024-fold interpolation (analog incremental signals)
- 1-fold, 2-fold, 4-fold edge evaluation (incremental square-wave signals)
- Input of preset value (counter preset)
- Change of counting direction
- Change of "Start Counter" parameters

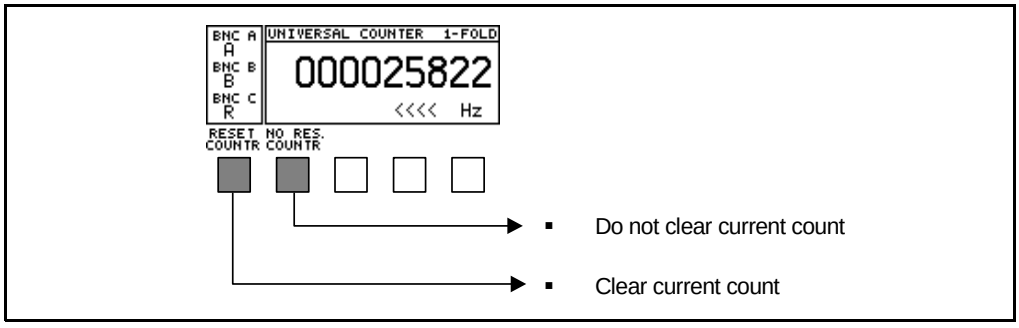
Automatically clear UNIVERSAL COUNTER



Note

Possible in PWM and PWT mode!

Manually clear UNIVERSAL COUNTER

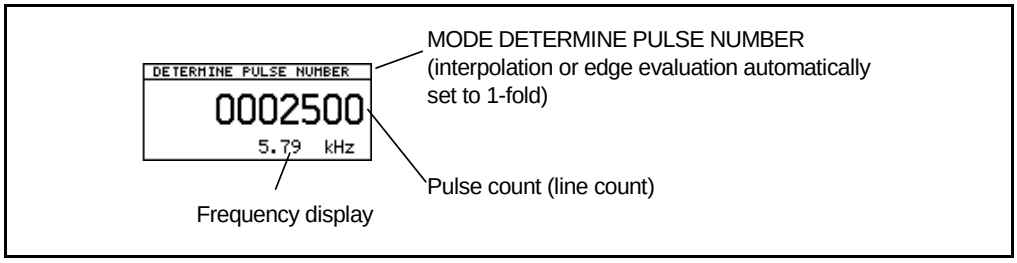


Note

Only possible if the EXPERT MODE is active in the PWM MODE.

5.3.11 Mode DETERMINE PULSE NUMBER

The PULSE NUMBER function has been developed to determine the line counts of rotary encoders.
This simple method is also suitable for testing the counting function and reference signal function of linear encoders.



Measuring function

1. When "DETERMINE PULSE NUMBER" is activated the PULSE COUNTER is cleared and the interpolation or edge evaluation set to 1-fold.
2. The counter "waits" and the first reference mark starts the PULSE COUNTER.
   The counter starts counting.
3. The next reference mark stops the counter; the display contains the number of increments that were counted between the two reference marks.
4. The display remains "frozen" until the next reference mark is reached (counter break).
   Then the cycle (1 to 4) restarts.

Note

Difference to the PWT MODE:

In the function DETERMINE PULSE NUMBER of the PWT MODE each reference mark is evaluated (without counter breaks); see "PWT bar display of ref. mark width and position" on page 196.
Each reference mark restarts the counter and the current count is displayed.

See linear encoders example.

Example 1: Rotary encoder with 2048 lines per revolution

1)
- Start DETERMINE PULSE NUMBER (press soft key)
- Counter sets display to 0 (reset)
- Counter "waits" for reference mark

Note:
Reference mark is abbreviated as RM!

2)
Counter starts when an RM is traversed and counts until the next RM is reached.

3)
Counter stops when the RM is reached; line count is displayed.

Note:
The current count must be identical with the line count on the ID plate of the rotary encoder!
If this is not the case, the RM function of the encoder is faulty.

4)
The current count display is "frozen" until the next RM is reached (minimum display time: approx. 0.5 seconds).

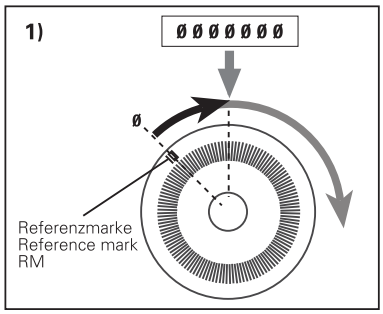
After an idle cycle "Determine pulse number" restarts. (Counter reset and start with RM, continue with item 2)

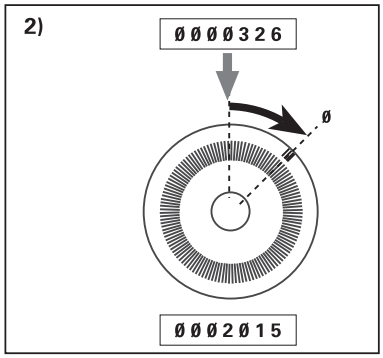
Note:
During the display period (0.5 seconds) no pulse count is determined (idle cycle). In the event of high speeds this may take several revolutions.

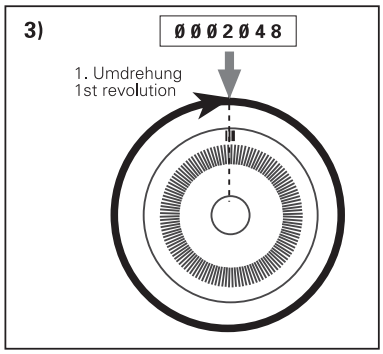
5)
Changing the direction of rotation changes the sign.

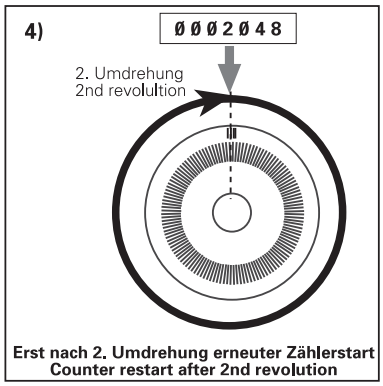
Note:
In the PWT MODE each RM sets the counter to zero (reset)! The counter restarts counting with each RM.

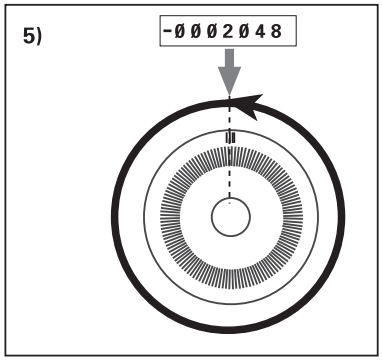
If the error message FREQU > is displayed, the scanning frequency is exceeded and the test result invalid (see "PWT bar display of ref. mark width and position" on page 196.)









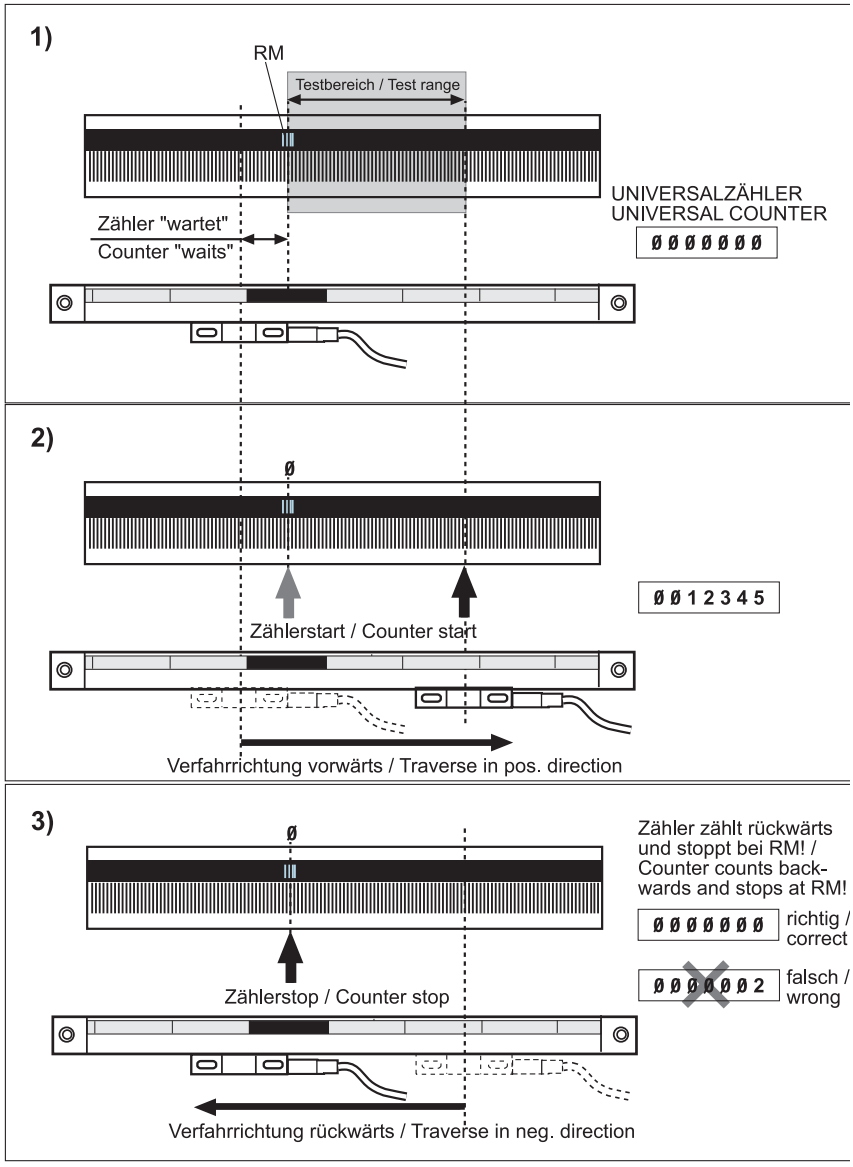


Example 2: Test of counting function of a linear encoder with 1 reference mark (RM)

1)
Position the scanning unit "next to" the RM.
Press PULSE NUMBER soft key
- Counter reset
- Counter "waits" for RM

2)
Traverse scanning unit over RM.
Counter starts with RM and counts the measuring range.

3)
Traverse back over RM.



Note

If the RM and counting functions of the linear encoder are error-free, the **PULSE NUMBER display is 0**!

If it is not 0, the RM function of the encoder is faulty!

5.3.12 MEASURE U/I mode

The PWM/PWT mode MEASURE U/I serves to measure current consumption and supply voltage of the encoder.

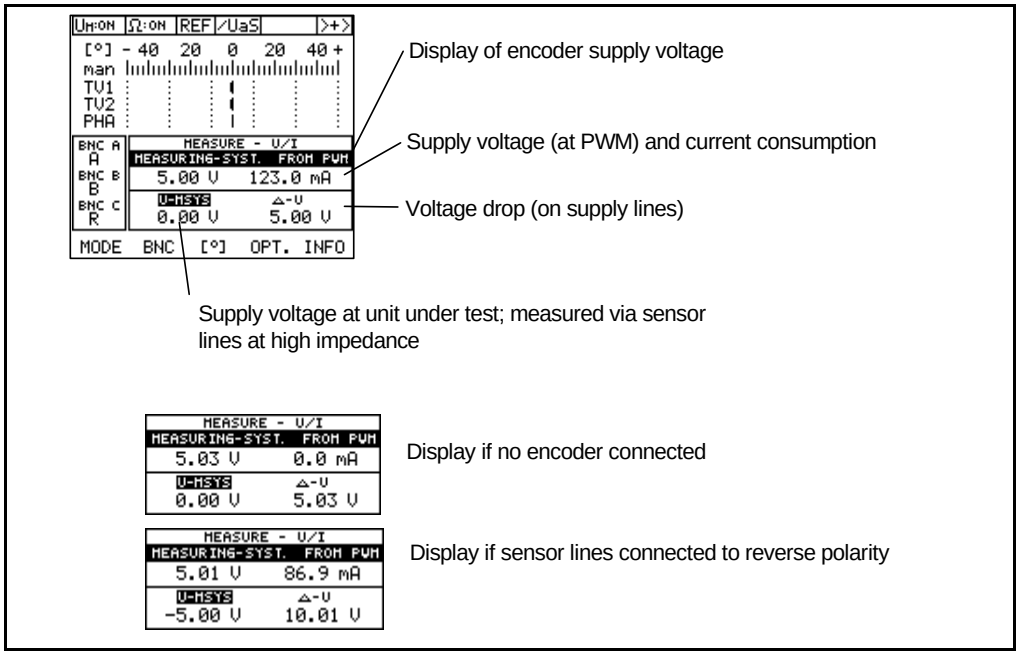
Note

Depending on the interface board the sensor voltages may be supported as well.

The sensor lines in subsequent electronics have the task to tap the encoder supply voltage with high resistance directly at the encoder and to lead it back to the subsequent electronics.

Voltage drops on the encoder supply lines can then be compensated in subsequent electronics equipped for this purpose.

Many TTL, HTL and 1 Vpp encoders feature sensor lines.


Display of encoder supply voltage
Supply voltage (at PWM) and current consumption
Voltage drop (on supply lines)
Supply voltage at unit under test; measured via sensor lines at high impedance
Display if no encoder connected
Display if sensor lines connected to reverse polarity
MEASURE - U/I
MEASURING-SYST. FROM PWM
5.00 V 123.0 mA
U-MSYS Δ-U
0.00 V 5.00 V
MODE BNC [°] OPT. INFO

Note

In the PWM/PWT mode MEASURE U/I the encoder supply lines and the sensor lines are separated.

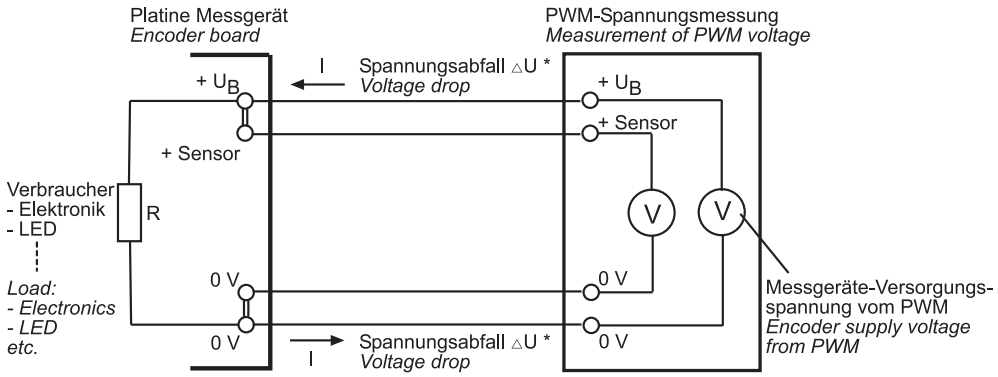
In all other PWM MODEs the encoder supply lines are connected to the sensor lines in order to reduce the voltage drops on the encoder supply lines.

The current consumption of the terminating resistors (with TTL and HTL interface boards) is displayed in the current display together with the current consumption of the encoder.

Attention

If the PWM 9 is connected in series to a subsequent electronics that supports the remote-sense mode (e.g. HEIDENHAIN interface card), it should not be in the MEASURE U/I MODE when the voltage of the subsequent electronics is switched on.
Reason:
When the subsequent electronics is switched on, it measures the sensor voltage and adjusts the encoder supply voltage according to the measured value.
In the MEASURE U/I MODE the PWM 9 opens the sensor lines to the encoder to enable the PWM to measure the sensor voltage. Therefore, the voltage drop between the PWM 9 and the subsequent electronics cannot be taken into account.
If there are long lines between **PWM 9 and measuring system** or if the currents (LC) are high, the voltage drop on the lines may be very high and therefore impair the function of the measuring system.

Example: Sensor voltage



* The **voltage drop** for HEIDENHAIN cables is calculated as follows:

$$\Delta U[V] = 2 \cdot 10^{-3} \cdot \frac{L_K[m] \cdot I[mA]}{56 \cdot A_V[mm^2]}$$

where
L_K: cable length
I: current consumption of encoder (from PWM or EXTERNAL)
A_V: wire diameter of supply line

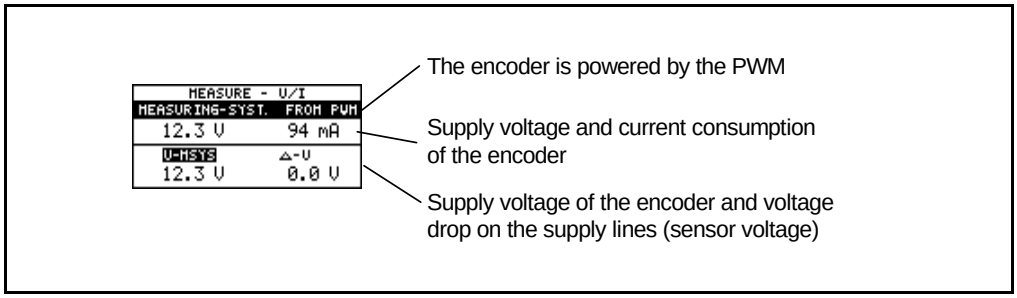
Displays in the PWM MODE MEASURE U/I

Note

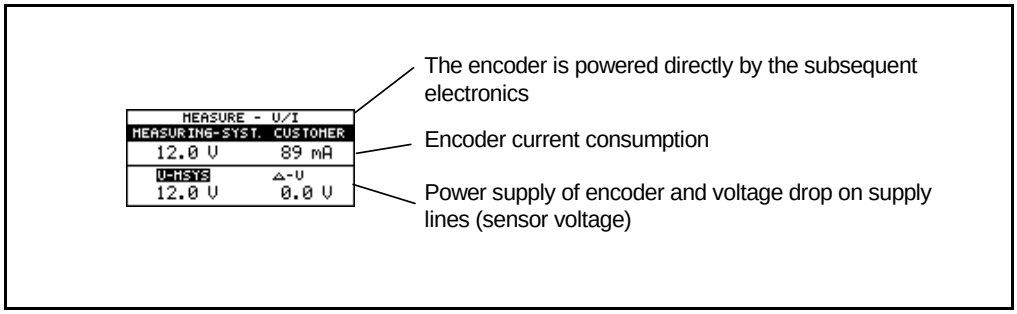
Depending on the selected power supply (from PWM or EXTERNAL) different information may be displayed.

MEASURE U/I MODE on encoders with sensor lines
(TTL, HTL, 1 Vpp interface boards)

- Encoder powered via PWM (parameter P2 U-MSYS: from PWM)
  (see "Parameter settings" on page 79).

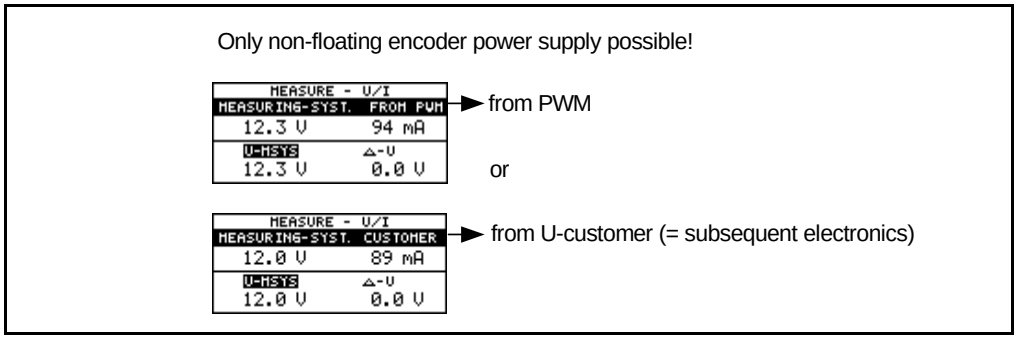

MEASURE - U/I
MEASURING-SYST. FROM PWM
12.3 V 94 mA
U-MSYS Δ-U
12.3 V 0.0 V
The encoder is powered by the PWM
Supply voltage and current consumption of the encoder
Supply voltage of the encoder and voltage drop on the supply lines (sensor voltage)

- Encoder powered via subsequent electronics (parameter P2 U-MSYS EXTERNAL)


MEASURE - U/I
MEASURING-SYST. CUSTOMER
12.0 V 89 mA
U-MSYS Δ-U
12.0 V 0.0 V
The encoder is powered directly by the subsequent electronics
Encoder current consumption
Power supply of encoder and voltage drop on supply lines (sensor voltage)

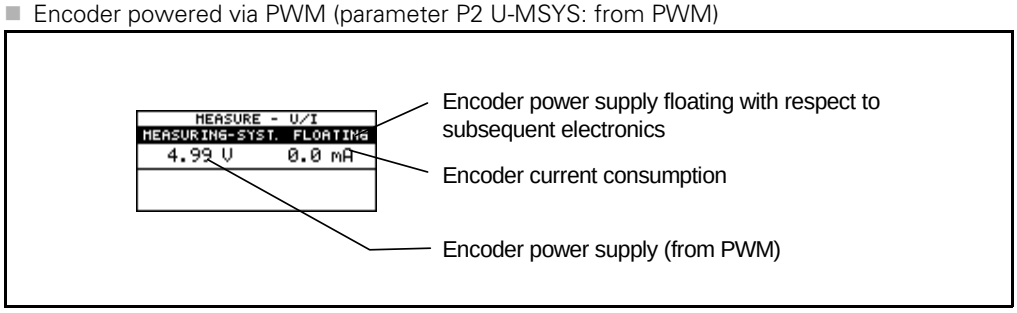
Special feature of HTL interface board
Floating power supply is not possible (parameter P2 U-MSYS: from PWM or EXTERNAL).

MEASURE U/I with HTL interface board:

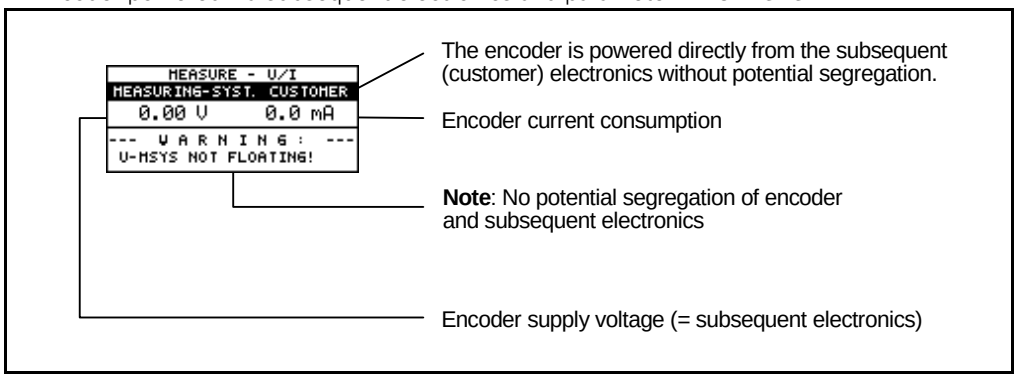


MEASURE U/I MODE on encoders without sensor lines
(11 µApp interface board)

- Encoder powered via PWM (parameter P2 U-MSYS: from PWM)


MEASURE - U/I
MEASURING-SYST. FLOATING
4.99 V 0.0 mA
Encoder power supply floating with respect to subsequent electronics
Encoder current consumption
Encoder power supply (from PWM)

- Encoder powered via subsequent electronics and parameter P2 U-MSYS EXTERNAL


MEASURE - U/I
MEASURING-SYST. CUSTOMER
0.00 V 0.0 mA
--- W A R N I N G : ---
U-MSYS NOT FLOATING!
The encoder is powered directly from the subsequent (customer) electronics without potential segregation.
Encoder current consumption
Note: No potential segregation of encoder and subsequent electronics
Encoder supply voltage (= subsequent electronics)

5.3.13 MEASURE AMPLITUDE mode

In this mode the peak-to-peak values of the signal amplitudes of the incremental signals 1 and 2 are measured. The measuring result is always the amplitude of a single signal period.

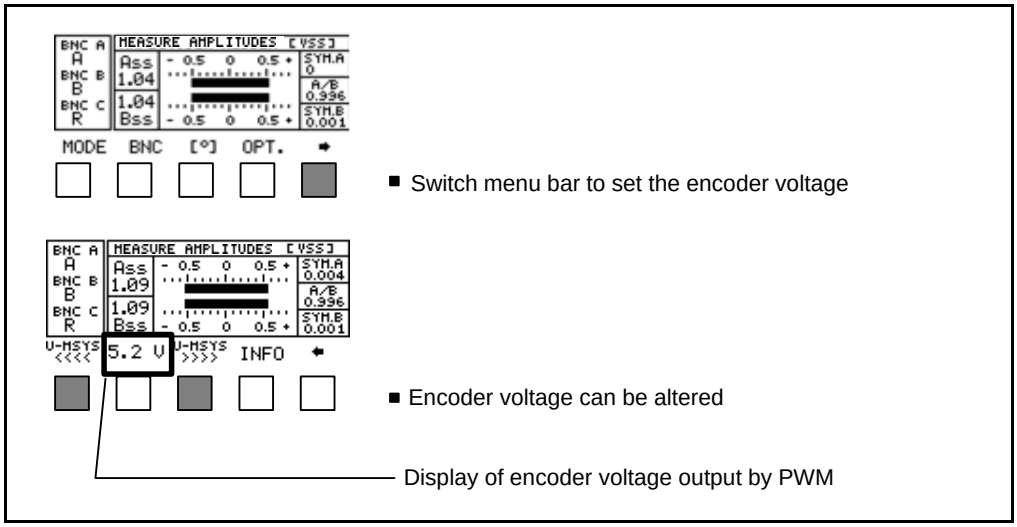
Note

With sinusoidal encoder signals (11 µApp and 1 Vpp) the positive and the negative peaks are measured against U0, with square-wave encoder signals (TTL and HTL) the LOW level and the HIGH level are measured against 0 V.

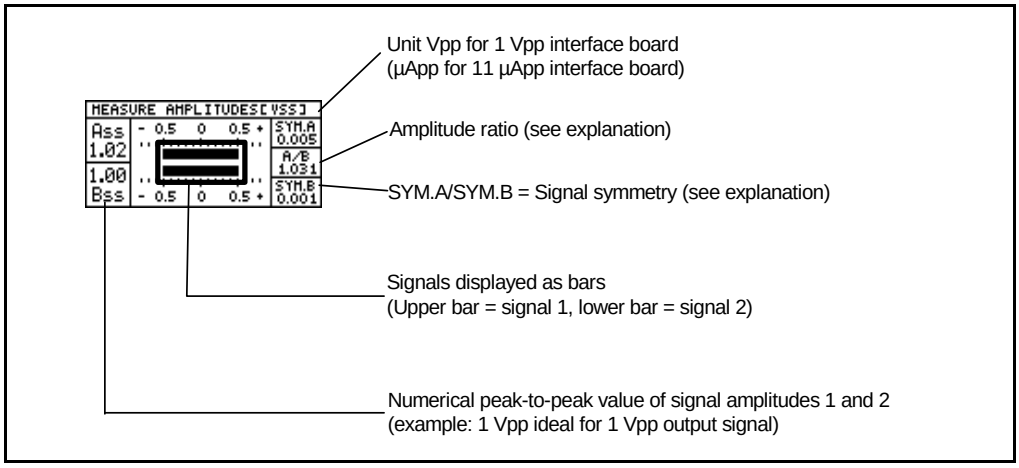
The maximum measuring ranges for the different interface boards are listed in the table below:

Interface board	11 µApp	1 Vpp / absolute 1 Vpp	TTL	HTL
Max. measuring range	33 µApp PWM MODE 17 µApp PWM MODE	1.66 Vpp	low: 0 – 2.5 V high: 2.5 – 7.5 V	low: 0 – 7.5 V high: 7.5 – 22.5 V

If the EXPERT MODE is active the encoder supply can be altered in the MEASURE AMPLITUDE MODE when using the 11 App or the 1 Vpp interface boards.



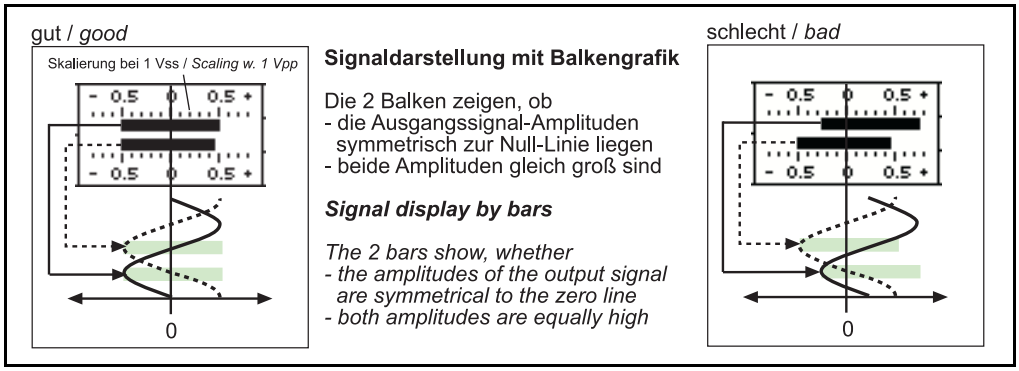
Explanation of the display for 1 Vpp and 11 µApp signal amplitude measurement



Note

Permissible tolerances for the output signals see “Interface Description" on page 115.

Explanation:


gut / good
Skalierung bei 1 Vss / Scaling w. 1 Vpp
- 0.5 0 0.5 +
- 0.5 0 0.5 +
0
Signaldarstellung mit Balkengrafik
Die 2 Balken zeigen, ob
- die Ausgangssignal-Amplituden symmetrisch zur Null-Linie liegen
- beide Amplituden gleich groß sind
Signal display by bars
The 2 bars show, whether
- the amplitudes of the output signal are symmetrical to the zero line
- both amplitudes are equally high
schlecht / bad
- 0.5 0 0.5 +
- 0.5 0 0.5 +
0

Note

The bar display allows for "rough estimation".
Exact values are obtained by measuring the on-to-off ratio and the amplitude ratio etc.
An oscilloscope is recommended for signal evaluation!

Display of the signal symmetry (SYM.1 and SYM.2)

Measuring the signal amplitude with 11 µApp interface board

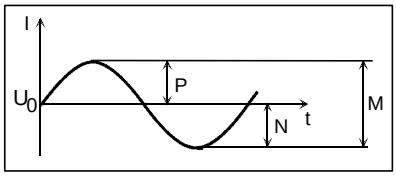
SYM.1: Symmetrie1, Verhältnis positiver zu negativer Halbwelle von Inkrementalsignal Ie1
Symmetry1, ratio of positive to negative half-wave of incremental signal Ie1

SYM.2: Symmetrie2**,** Verhältnis positiver zu negativer Halbwelle vom Inkrementalsignal Ie2

Berechnung: $\left|\frac{P-N}{2xM}\right|$ Ergebnis: Ideal = 0

Symmetry2, ratio of positive to negative half-wave of incremental signal Ie2

Calculation: $\left|\frac{P-N}{2xM}\right|$ *Result: ideal = 0*

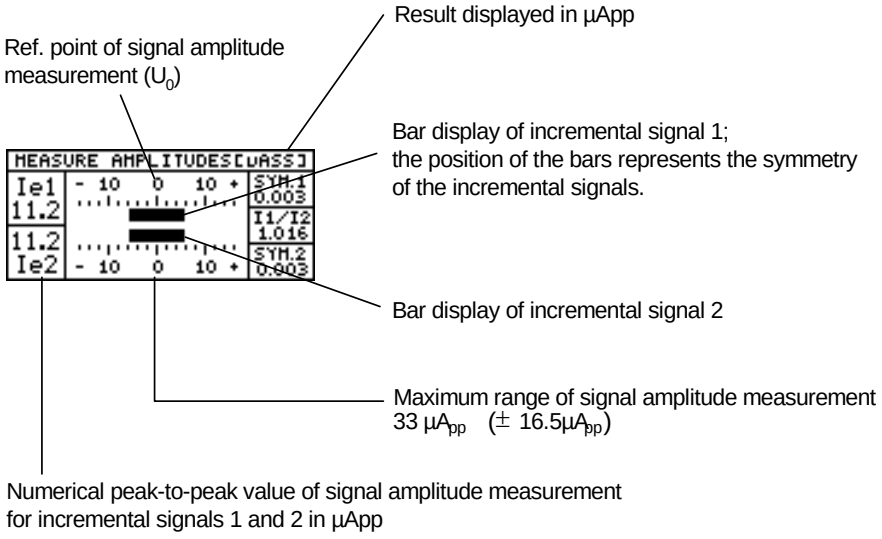


I1 / I2: Amplitudenverhältnis, Signalamplitude Inkrementalsignal Ie1 zu Ie2

Berechnung: $\left|\frac{M_{Ie1}}{M_{Ie2}}\right|$ Ergebnis: Ideal = 1

Amplitude ratio, signal amplitude increm. signal Ie1 to Ie2

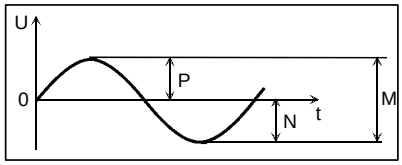
Calculation: $\left|\frac{M_{Ie1}}{M_{Ie2}}\right|$ *Result: ideal = 1*


Result displayed in µApp
Ref. point of signal amplitude measurement (U0)
MEASURE AMPLITUDES[uASS]
Ie1
11.2
- 10 0 10 +
SYM.1
0.003
I1/I2
1.016
SYM.2
0.003
11.2
Ie2
- 10 0 10 +
Bar display of incremental signal 1; the position of the bars represents the symmetry of the incremental signals.
Bar display of incremental signal 2
Maximum range of signal amplitude measurement 33 µApp (± 16.5µApp)
Numerical peak-to-peak value of signal amplitude measurement for incremental signals 1 and 2 in µApp

Measuring the signal amplitude with 1 Vpp interface board (and absolute/1 Vpp)

SYM.A: Symmetrie A, Verhältnis positiver zu negativer Halbwelle vom Inkrementalsignal A.
Symmetry A, ratio of positive to negative half-wave of incremental signal A.

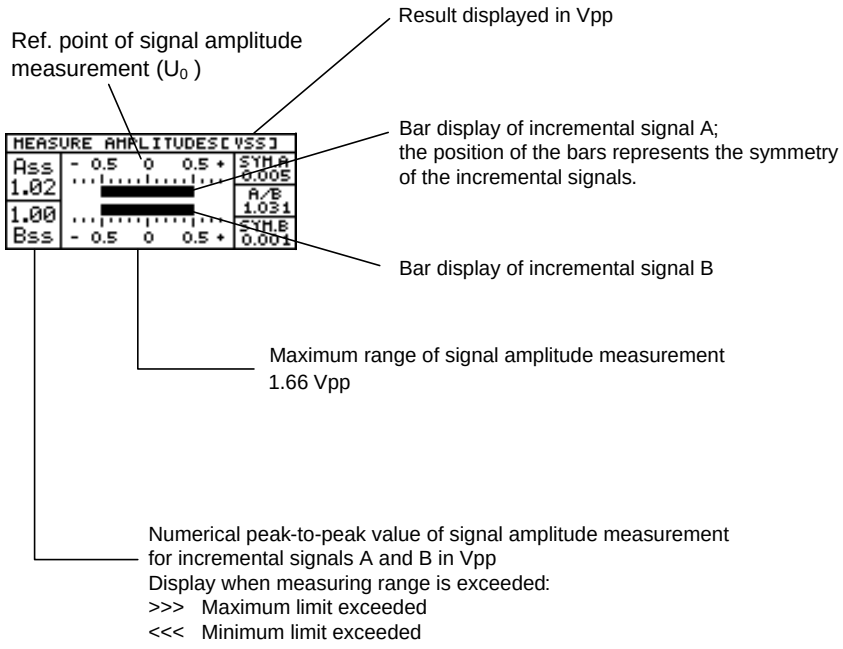
SYM.B: Symmetrie B**,** Verhältnis positiver zu negativer Halbwelle vom Inkrementalsignal B.
Symmetry B, ratio of positive to negative half-wave of incremental signal B.



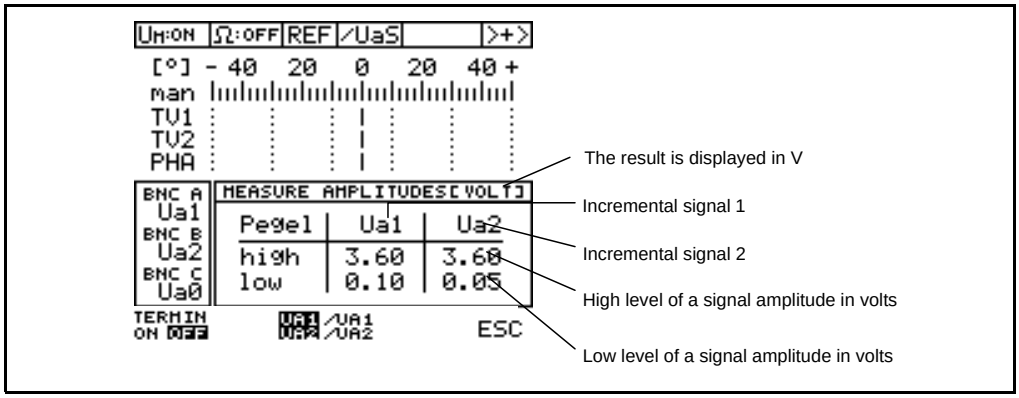
Berechnung: $\left|\frac{P-N}{2 \times M}\right|$ Ergebnis: Ideal = 0
Calculation: *Result: ideal = 0*

A / B: Amplitudenverhältnis, Signalamplitude Inkrementalsignal A zu B
Amplitude ratio, signal amplitude increm. signal A to B

Berechnung: $\left|\frac{M_A}{M_B}\right|$ Ergebnis: Ideal = 1
Calculation: *Result: ideal = 1*



Measuring the signal amplitude with TTL or HTL interface board



In the related soft-key row the following settings can be made:

TERMIN ON OFF	Activate or deactivate the terminating resistors (defined load of the square-wave signals). The active selection is highlighted.
UA1 /UA1 UA2 /UA2	Switch to the inverted signals. (In the field there are HTL encoders that do not operate with cross signals ($\overline{Ua1}$, $\overline{Ua2}$, $\overline{Ua0}$). In this case the display of the inverted signals is „ - - - - „.)
ESC	Terminate signal amplitude measurement.

Note

When do you have to activate the terminating resistor?

Setting for square-wave interfaces (TTL/HTL):

"ON" **Standard setting**. The terminating resistor is active irrespective of whether there is a subsequent electronics.

"OFF" Can be switched off for testing. (Reduction of the driving current of the subsequent electronics; not required for standard tests!)

Setting for 1Vpp interfaces:

"ON" **Standard setting**. The terminating resistor is active irrespective of whether there is a subsequent electronics.

"OFF" The terminating resistor is only switched off, if the adapter cable ID 324556-01 (no longer part of our product range; replaced by Interface board absolute / 1Vpp ID 312186-02) is used.

5.4 EXPERT MODE

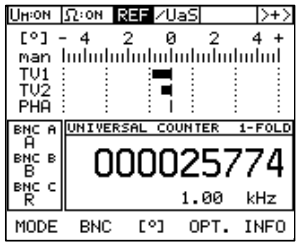
Activating the EXPERT-MODE see “Activating the EXPERT MODE" on page 100.

In addition to the basic functions, in the EXPERT MODE the PWM offers further (expert) functions:

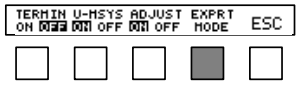
- Parameter programming
- Changing the encoder power supply
- Setting the interpolation
- Input of a preset
- PEAK HOLD function (storage of peak value)

5.4.1 Selecting EXPERT MODE functions

Example: PWM MODE and EXPERT MODE are set

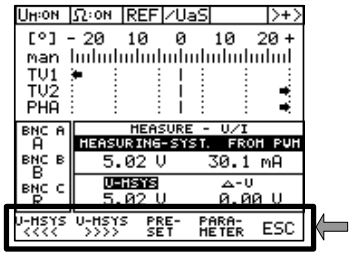


■ Press OPT



■ Press EXPERT MODE

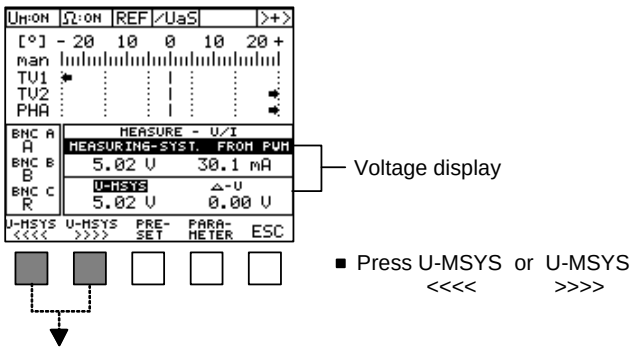
Note:
Depending on the parameter settings, other soft keys may be displayed!



EXPERT MODE functions
- U-MSYS
- PRESET
- PARAMETER

can be selected

5.4.2 Changing the U-MSYS supply voltage



U-MSYS <<<<	Reduce U-measuring system: The supply voltage of the measuring system can be reduced to approx. 3 V (HTL interface board: 10 V).
U-MSYS >>>>	Increase U-measuring system: The supply voltage of the measuring system can be increased to approx. 6 V (9 V*) (HTL interface board: 19 V, when operated with the 24 V PWM power supply unit). Parameter P3: U-MSYS limited to approx. 6 V (standard setting); limit can be increased to 9 V.

For testing the encoder supply voltage can be altered by pressing the keys "U-MSYS<<<<" or "U-MSYS>>>>".

Without subsequent electronics:

The connected encoder is powered with the optimum voltage (depending on the interface board. Example: For a 1 Vpp interface board 5 V are set.)

With subsequent electronics:

The connected encoder is powered with the same voltage as is fed to the subsequent electronics.
Example: The NC provides an encoder power supply of 4.85 V; the PWM also sets the encoder voltage to 4.85 V.

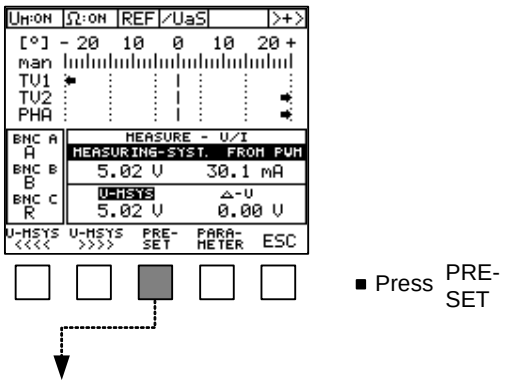
Note

This function serves to check and simulate voltage drops on lines and voltage monitoring on subsequent electronics.

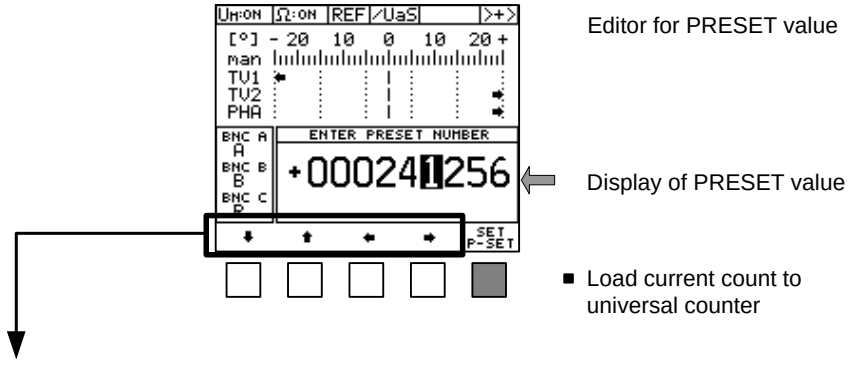
5.4.3 Input of PRESET VALUE

Note

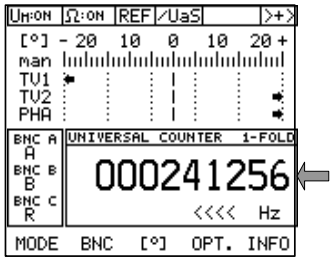
If the PWM is operated as parallel counter in a position control loop, a preset value can be entered which corresponds to that of the subsequent electronics.
PWM counter and subsequent electronics can be started simultaneously via parameter 9.
In this mode both current counts can be compared during axis traverse!



PRE-SET	Activate the PRESET editor. For the UNIVERSAL COUNTER a preset value can be entered.



↓ ↑	Set preset size and sign.
← →	Select the decade.



Selected PRESET was loaded to UNIVERSAL COUNTER

Note

With the parameter settings the PWM can be adapted individually to the subsequent electronics.
(For parallel measurement: Counting direction, interpolation and start counter with ref. mark.)
See “Parameter P6 = Set INTERPOLATION" on page 86.

5.4.4 PEAK HOLD

Note

The maximum value memory of the PHA/TV display (PEAK HOLD marks) only functions in the PWM MODE with active EXPERT MODE and after manual activation by PEAK H. START!

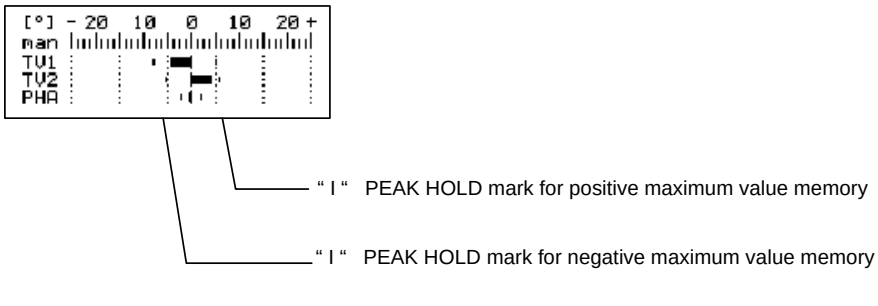
The PEAK HOLD function does not work together with automatic scaling of the TV/PHA display (see “Display of on-to-off ratio and phase shift" on page 57)!

The maximum value memory shows the positive and the negative maximum value of the PHA/TV error by means of marks.

The maximum value memory is deleted by changing the MODE. With automatic switch-over of the measuring range the maximum value memory of the PHA/TV display is inactive.

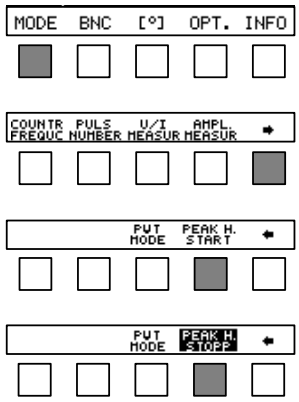
Note

The machine axis must traverse continuously!
The measuring range between START and STOP is checked and the PEAK HOLD marks of the TV-/PHA display are frozen.
The START/STOP key must be pressed while the axes are moving, as otherwise the MIN/MAX memory will be deleted!


[°] - 20 10 0 10 20 +
man
TV1
TV2
PHA
“ I “ PEAK HOLD mark for positive maximum value memory
“ I “ PEAK HOLD mark for negative maximum value memory

Starting and stopping the maximum value memory by hand:

The keys for manual operation are part of the MODE soft-key row:

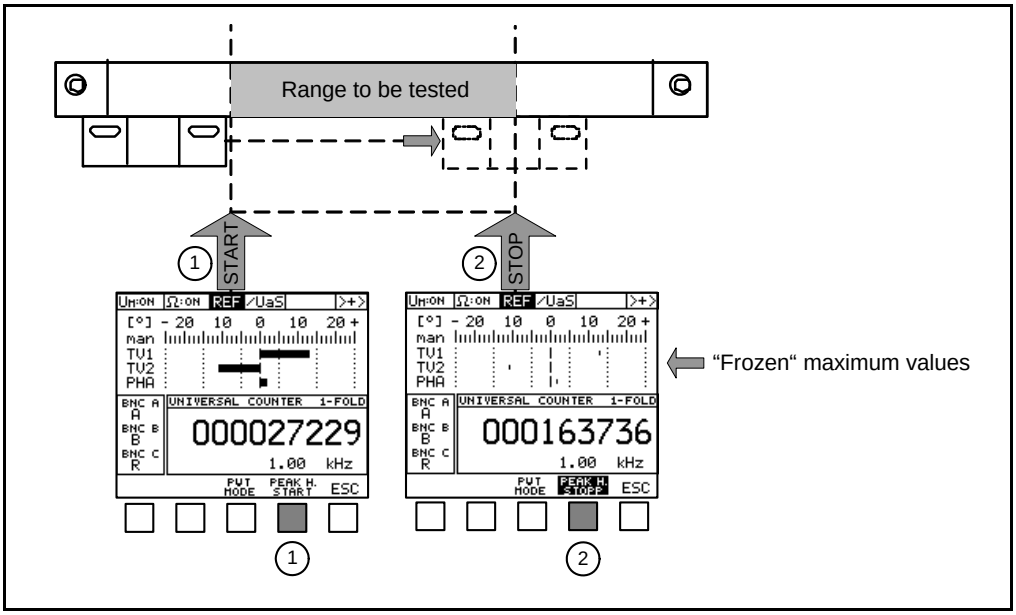


- Start manual control of PEAK HOLD display
- Stop manual control of PEAK HOLD display

PEAK H. START	This soft key serves to start the PEAK HOLD display manually. An already existing PEAK HOLD display is deleted.
PEAK H. STOP	After the START key was pressed, the STOP key is displayed. Pressing the STOP soft key freezes the PEAK HOLD marks in the display and the bars of the PHA/TV display disappear. The extremes can now be read.
PEAK H. STOP	When the STOP soft key is pressed, it is displayed inversely which represents the "frozen" status. Pressing the inversely displayed STOP soft key terminates the PEAK HOLD function.

Example of a PEAK HOLD application:

On a linear encoder, a **defined measuring range** in which a defect is assumed is to be checked with PEAK HOLD.



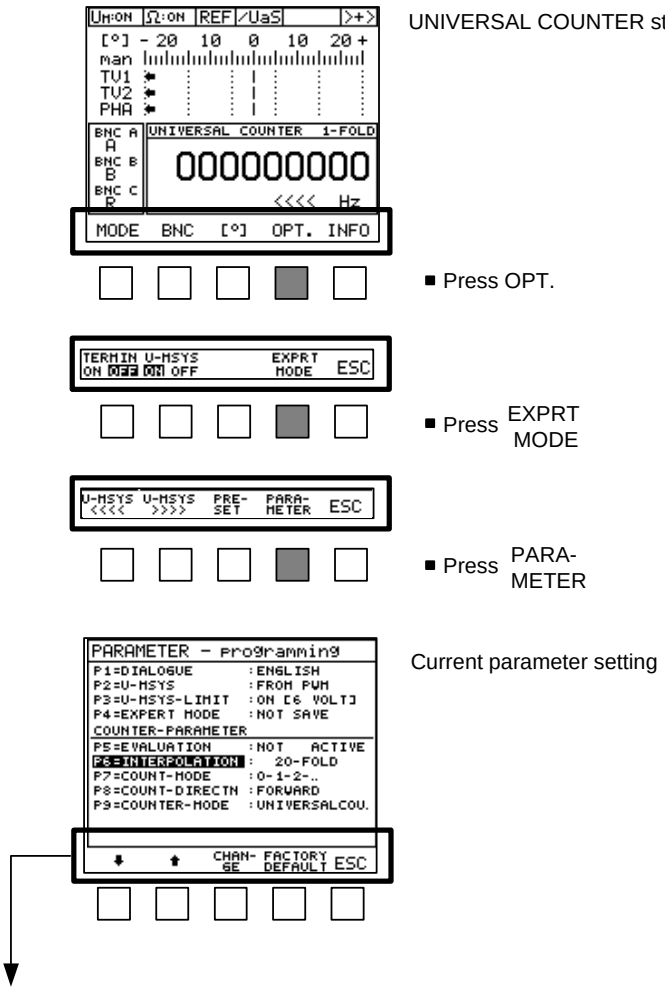
5.4.5 Description of PARAMETER programming

PWM functions can be altered via PARAMETER programming.

Note

The parameter range is only accessible when the EXPERT MODE is active.

Entering the PARAMETER MODE (example):



↓ ↑	Select parameter with up/down buttons.
CHAN-GE	The inversely displayed parameter can be changed by soft key.
FACTORY DEFAULT	Resets the PWM to factory setting. (P1 = DIALOG remains unchanged)
ESC	Terminates PARAMETER programming.

Note

Changes to parameters come into effect immediately and are non-volatile, i.e. when the PWM is switched on, it will start with the new settings.
Exception:
Parameter P3=U-MSYS-LIMIT is always reset to "ON [6 volts]"!

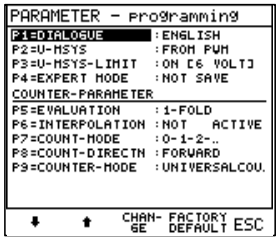
5.4.6 Parameter settings

Note

The parameter description is valid for the interface boards:
1 Vpp, 11 µApp, TTL and HTL.

The multi-functional absolute/1 Vpp interface board differs in parameter view and operation (see "1 Vpp Absolute Interface Board" on page 201).

Parameter P1 = Dialog language



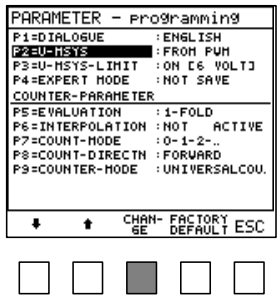
P1 = DIALOG: - GERMAN (factory setting)
- ENGLISH
- FRENCH

Parameter P2 = Selection of encoder operating voltage

In P2 = U-MSYS two settings can be selected:

1. FROM PWM
2. EXTERNAL

1. Parameter P2 setting FROM PWM selected

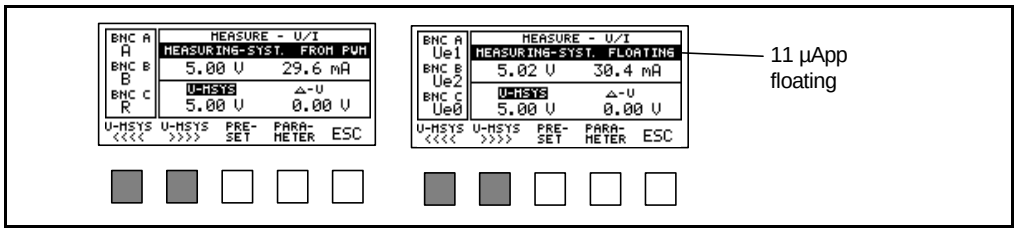


Note

With the parameter setting "P2 = from encoder" the encoder is powered by the PWM 9.
If no subsequent electronics is connected the basic setting of the encoder power supply by the PWM 9 is 5 V (except when operating with HTL interface board; in this event the voltage is 12 V.)
If a subsequent electronics is connected to PWM 9, the PWM measures the voltage of the subsequent electronics and then powers the encoder **with the same** voltage.
Example: If the subsequent electronics provides 4.8 V, the PWM 9 also sets the power supply to 4.8 V.

The current limit of the encoder voltage is set to 500 mA.

By means of floating power supply reliable operation of subsequent electronics with 11 µApp and 1 Vpp encoder interfaces is ensured.



The voltage level of the encoder supply can be altered for diagnosis.
The basic setting is 5 V (12 V for HTL interface board).

Why is potential separation of PWM and subsequent electronics (11 µApp interface) required?

Due to different reference potentials of the 11 µApp encoder signals and the interface boards (0 V) the signals **may** be shifted. The signal shifts can cause counting errors in the subsequent electronics, and - in the most unfavorable case - generate an error in the measuring circuit. Potential separation prevents signal shift, and the machine axis operates correctly, even when the PWM is switched on.

DANGER

If you intend to disable potential separation, first check whether the machine axes are stable, i.e. will not move uncontrolled.

2. Parameter P2 EXTERNAL selected

Note

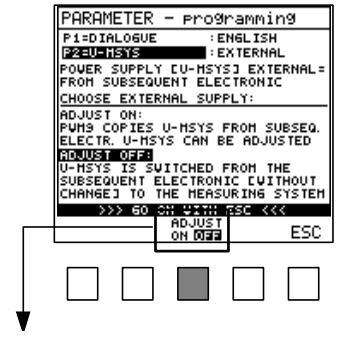
P2 "EXTERNAL" is only effective, if the encoder is powered by a subsequent electronics (TNC, ND, VRZ, ...)!

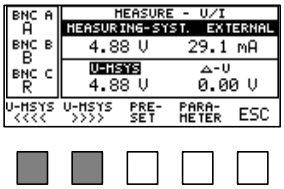
Otherwise an error message is displayed:

The PWM itself is always powered by the PWM power supply unit!

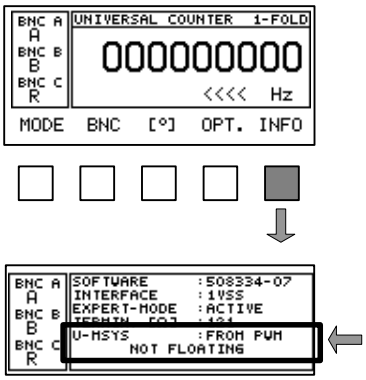
P2: EXTERNAL offers two settings:

1. ADJUST ON
2. ADJUST OFF



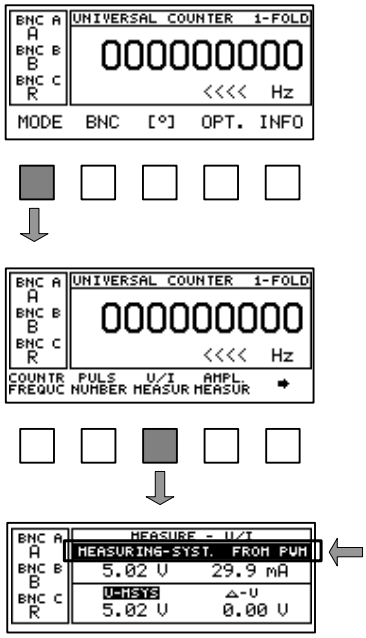
ADJUST **ON** OFF	The PWM copies the voltage provided by the subsequent electronics. Advantage: The voltage may be altered for diagnosis. Example: The subsequent electronics provides 4.7 V, the PWM outputs 4.7 V for the encoder via voltage controller. This voltage can be increased or reduced. 
ADJUST ON **OFF**	The encoder power supply of the subsequent electronics is looped through the PWM without changes (1:1) and is displayed.

Display of selected encoder voltage



- Open INFO screen

Information on encoder power supply.
In the example: Encoder powered from PWM.



The power supply source of the encoder is also displayed in the MEASURE U/I window, -> soft key MODE -> soft key MEASURE U/I.

Note

With the ADJUST ON setting the power drawn from the subsequent electronics is about 50 % higher than with ADJUST OFF (due to efficiency factors of switching controllers in the PWM).
Note that the voltage drop on the supply line from subsequent electronics to PWM is higher as well, due to the increased current intensity!

Information on measuring without potential separation (refers to 11µApp interface)

Attention

Subsequent electronics with 11 µApp encoder interfaces may no longer work properly owing to signal displacements (potential differences).

DANGER

Always check, whether the machine axes traverse steadily, i.e. not uncontrolled.

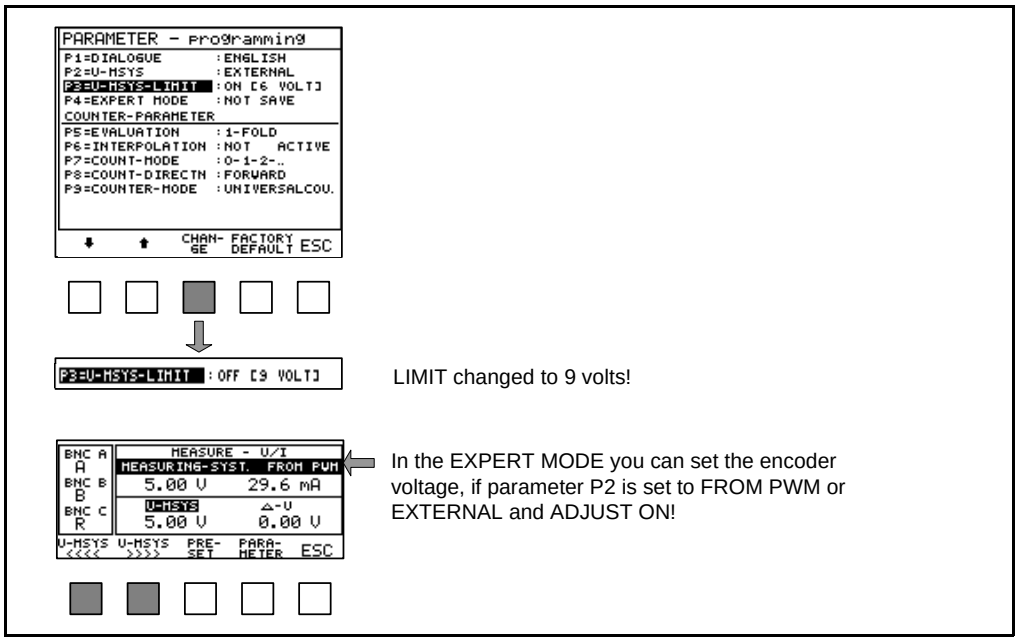
Note

The power drawn from the subsequent electronics to power the encoder is only slightly higher than the power requirement of the encoder. About 10 mA are used for the voltage monitoring of the subsequent electronics.

Parameter P3 = Limits of encoder power supply

Note

The parameter P3 U-MSYS-LIMIT defines the maximum limit of the encoder supply voltage. Factory setting: LIMIT 6 volts.
Standard encoders are operated with a voltage of 5 V ± 5 %!



DANGER

By switching LIMIT 6 V off it is possible to adjust the encoder voltage to 9 V (± 1 V).

Overvoltage may destroy the encoder!

Note

When you switch off the PWM, parameter P3 is always reset to factory setting (LIMIT 6 V)!
The parameter P3 is not active with HTL interface boards!

Parameter P4 = Save EXPERT MODE setting to non-volatile memory

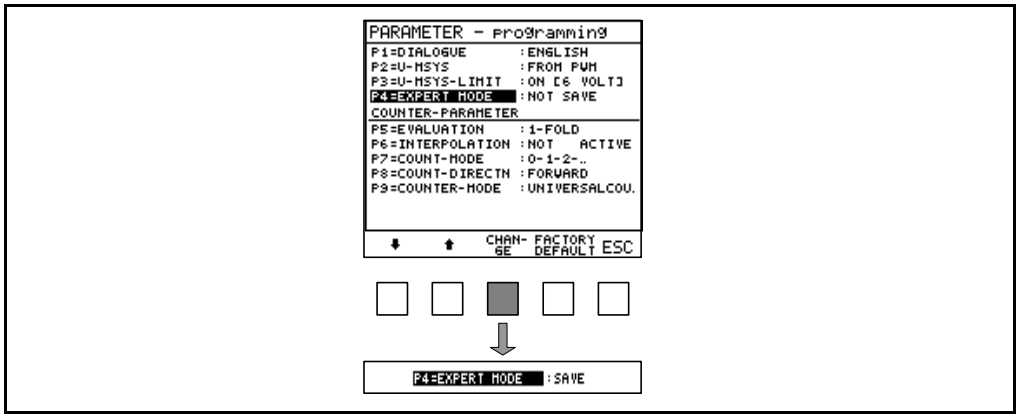
Two settings are possible:

Setting 1 (factory setting):
P4 = EXPERT MODE: NOT SAVE

If the EXPORT MODE was active, it is deactivated when the PWM power supply is interrupted.

Setting 2:
P4 = EXPERT MODE: SAVE

The EXPERT MODE remains active after an interruption of the PWM power supply (permanently stored)!



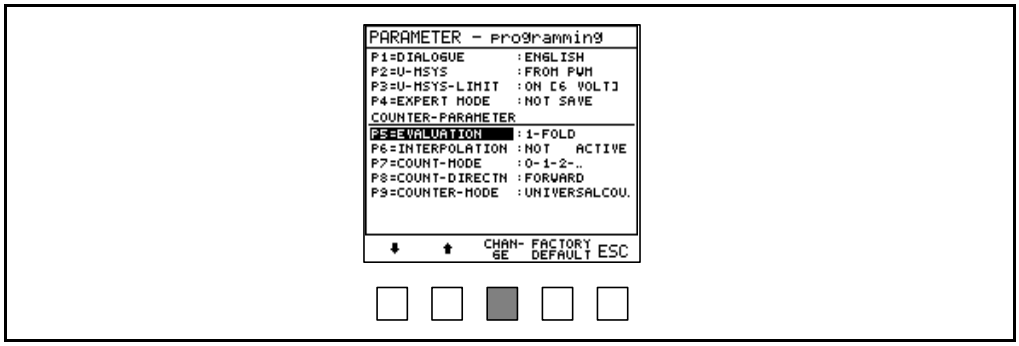
Parameter P5 = Edge evaluation

Note

The edge evaluation is only possible for encoders with square-wave output signals (TTL / HTL).

In parameter P5 three different settings can be made for the UNIVERSAL COUNTER.

P5 = EVALUATION: 1-FOLD
2-FOLD
4-FOLD

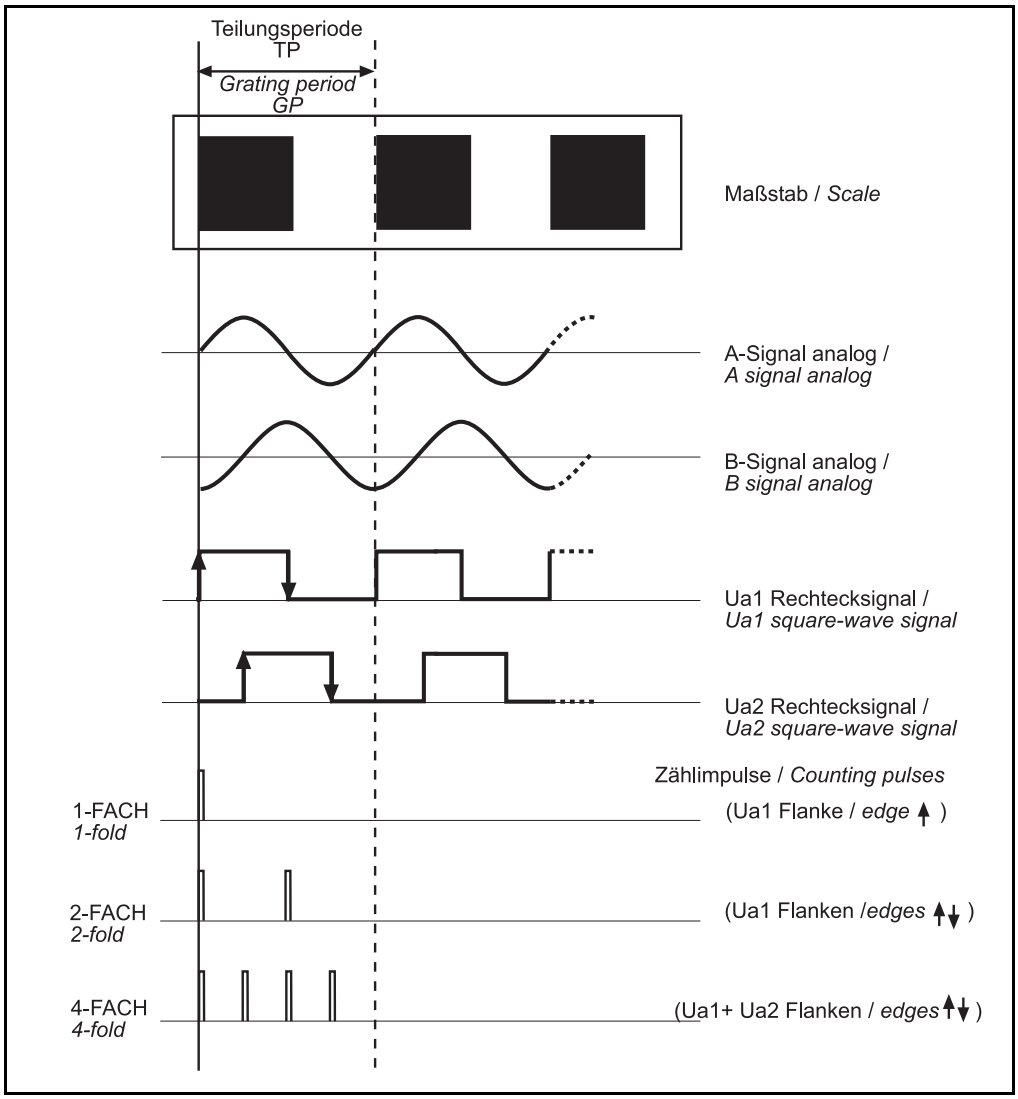


The edge evaluation determines how many edges per signal period of the incremental signals 1 and 2 are counted by the UNIVERSAL COUNTER.

Note

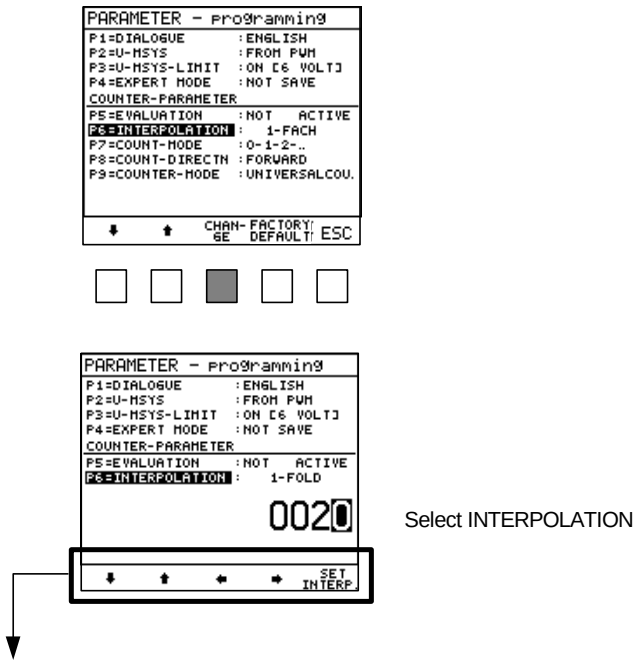
The PWM MODE DETERMINE PULSE NUMBER always uses 1-fold evaluation!
If you select an interpolation, the evaluation is "NOT ACTIVE"!

Explanation of edge evaluation:

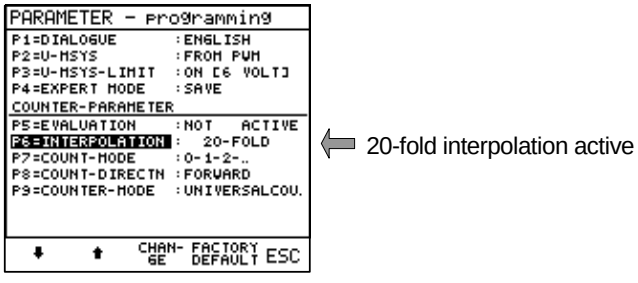


Parameter P6 = Set INTERPOLATION

P6 = INTERPOLATION: 1-FOLD ... 1024-FOLD selectable



⬇ ⬆	Select numerals 0 … 9.
⬅ ➡	Select decimal place.
SET INTERP.	Save interpolation (in the example: 20-fold).



Note

An interpolation can only be set for encoders with analog output signals (11 µApp, 1 Vpp).

Example:
Encoder signal period (SP) = 20 µm.
The resolution of the UNIVERSAL COUNTER (= counting step of the last digit) is to be 1 µm.

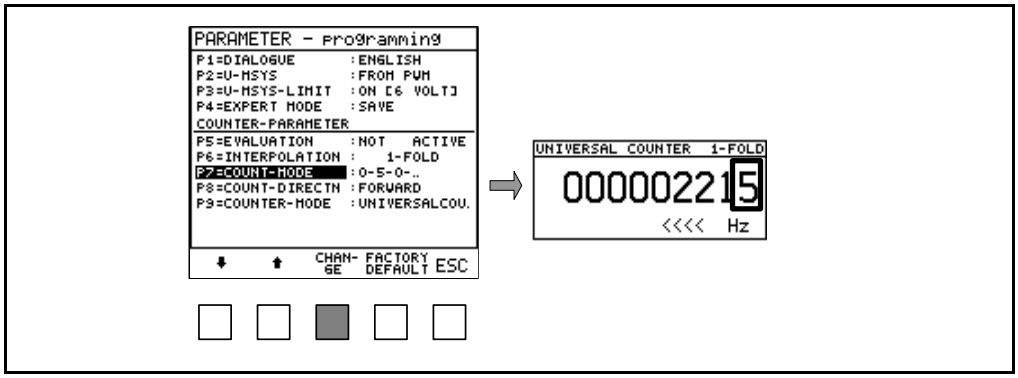
$$\text{Interpolation setting} = \frac{\text{Signal period of encoder}}{\text{Counting step}} \quad \frac{20\ \mu m}{1\ \mu m} = \text{Set 20-FOLD INTERPOLATION}$$

Parameter P7 = Counting mode

Note

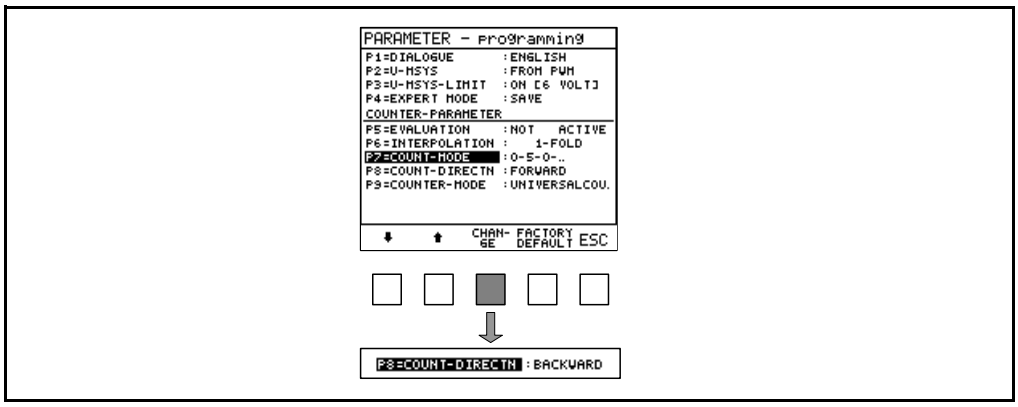
The parameter P7 defines the counting step of the last digit of the universal counter. This function is used to adapt the counting mode of the PWM to that of the subsequent electronics (parallel measurement). The counting mode can only be set for TTL and HTL interfaces.

In parameter P7 three different settings can be made for the UNIVERSAL COUNTER.
P7 = Counting mode: 0 - 1 - 2 - ..
0 - 2 - 4 - ..
0 - 5 - 0 - ..



Parameter P8 = Set COUNTING DIRECTION

P8 = COUNTING DIRECTION: FORWARD
BACKWARD



Note

The parameter P8 determines the counting direction of the UNIVERSAL COUNTER.

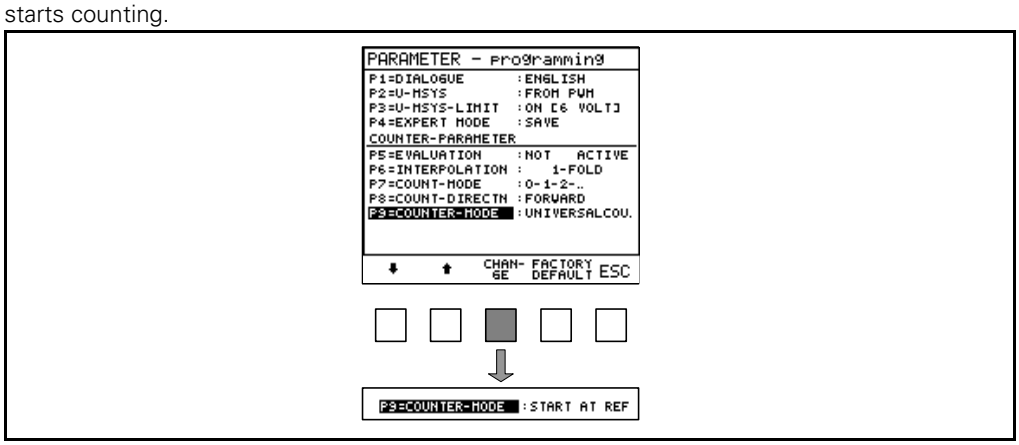
This function is used to adapt the counting direction of the PWM to that of the subsequent electronics (parallel measurement).

Parameter P9 = Set COUNTER MODE

P9 = COUNTER MODE: UNIVERSAL COUNTER (factory setting)
START WITH REF

The UNIVERSAL COUNTER setting is the standard counting function.

If set to START WITH REF, the UNIVERSAL COUNTER waits for a reference signal before it starts counting.



Note

A numerical value can be entered as preset for the UNIVERSAL COUNTER.
In this event the preset value is the start value of the counter.

This function is used to adapt the PWM UNIVERSAL COUNTER to the subsequent electronics (parallel measurement).

5.5 Measuring with the Multi-Functional Interface Board 1 Vpp, Absolute, Zn/Z1, EnDat, SSI

General

ID 312186-02

The 1 Vpp interface board serves to check the following encoder interfaces:

- Zn/Z1, 1 Vpp output signals (encoders with sine commutation)
- EnDat with 1 Vpp output signals
- SSI with 1 Vpp output signals
- Programmable SSI with 1 Vpp output signals

The interface board features 17-pin HEIDENHAIN flange sockets.
The desired encoder interface is selected in parameter P9 in the PWM EXPERT MODE or in the screen displayed during power-on.

5.5.1 Encoders with Zn/Z1 track and 1 Vpp interface

E.g. ERN 1185, ERN 1387 (with commutating signals)

With the interface card you can switch between the two output signal tracks (incremental signal AB, commutating signal CD). The encoder signals can be fed through the PWM to an oscilloscope.

The output signals A, B, R (incremental signals and reference mark) and CD (commutating signal) are checked in the same way as with a 1 Vpp interface.

Note

The PWM universal counter needs a minimum input frequency of 20 Hz to work.
When checking the CD commutating signal, the input frequency of 20 Hz is only obtained as of a shaft speed of 1200 rpm (CD signal = 1 signal period per revolution).

DANGER

The maximum mechanical speed of the encoder must not be exceeded!

Attention!
Due to different wiring possibilities it is essential that you read the section "Overview of the Adapter Cables" !

An adapter cable is available which is equipped with a PCB connector for direct connection to the encoder board. It serves to test encoders with different wirings with the PWM (see "Overview of the Adapter Cables" on page 101).

5.5.2 Encoders with EnDat and 1 Vpp interface

With the "SSI/EnDat" setting the incremental signals of absolute EnDat and SSI encoders can be checked in feed-trough mode.
Via the BNC sockets the incremental output signals (1 Vpp interface) and the EnDat data protocol can be switched to and evaluated with an oscilloscope.
The incremental signals are checked in the same way as with a 1 Vpp interface.

DANGER

Attention!
Due to different wiring possibilities it is essential that you read the section "Overview of the Adapter Cables" !

Note

EnDat and SSI encoders measure absolutely and do not feature reference marks!

The PWM cannot process absolute data protocols (EnDat or SSI).
For checking the absolute data protocols computer interface cards (EnDat and SSI interfaces), programming cables with T-coupler, test and programming software (programmable SSI interface) are available.

Please contact the HEIDENHAIN service, if you require such equipment!

If the BNC sockets receive digital and analog signals at the same time, the digital signals may crosstalk on the analog signals. The higher the band width of the connected oscilloscope, the more visible the crosstalk.
This effect only concerns the BNC outputs (no crosstalk can be observed at the OUT encoder output)!

5.5.3 Encoders with SSI and 1 Vpp interface (5 V operating voltage)

Note

Same functional range as encoders with EnDat interface:
1 Vpp output signals can be checked with the PWM; checking the absolute output signals requires an interface card or an oscilloscope (PWM BNC outputs).

5.5.4 Encoders with programmable SSI and 1 Vpp interface (10 - 30 V operating voltage)

Note

These are absolute encoders with programmable interface; on the ID plate there must be the interface designation SSI 09 or SSI 10!

Attention

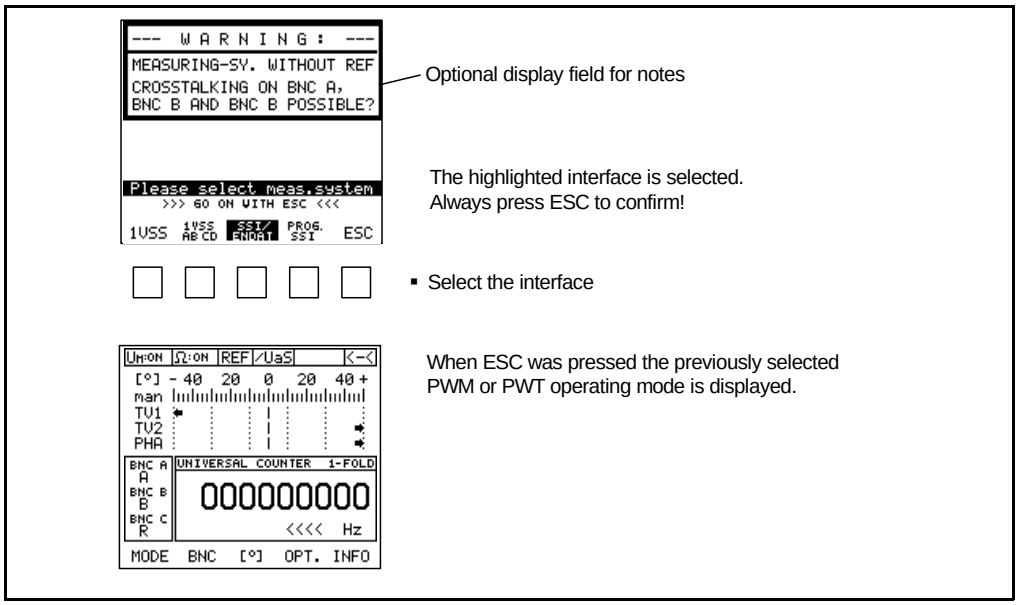
Operating voltage 10 - 30 V!
The high operating voltage needs to be **especially activated** in a parameter!
The other functions are the same as those of encoders with EnDat interface!
See "Possible settings when programmable SSI interface is selected" on page 94.

5.6 Operating the 1 Vpp Absolute Interface

Note

Insert the interface board and then activate the EXPERT MODE!

5.6.1 Selecting the interface on the power-on screen



The following interfaces can be selected:

1 VPP	1 Vpp interface, "standard" (Encoders without CD track, with 17-pin connector)
1 Vpp AB	Encoder with sinusoidal commutating track (Zn/Z1) Incremental track AB (= Zn)
1 Vpp CD	Encoder with sinusoidal commutating track (Zn/Z1) Iincremental track CD (= Z1)
SSI/ ENDAT	Encoder with EnDat or SSI interface
PROG. SSI	Encoder with programmed SSI interface (SSI 09 and SSI 10 with operating voltage 10 - 30 V)

Note

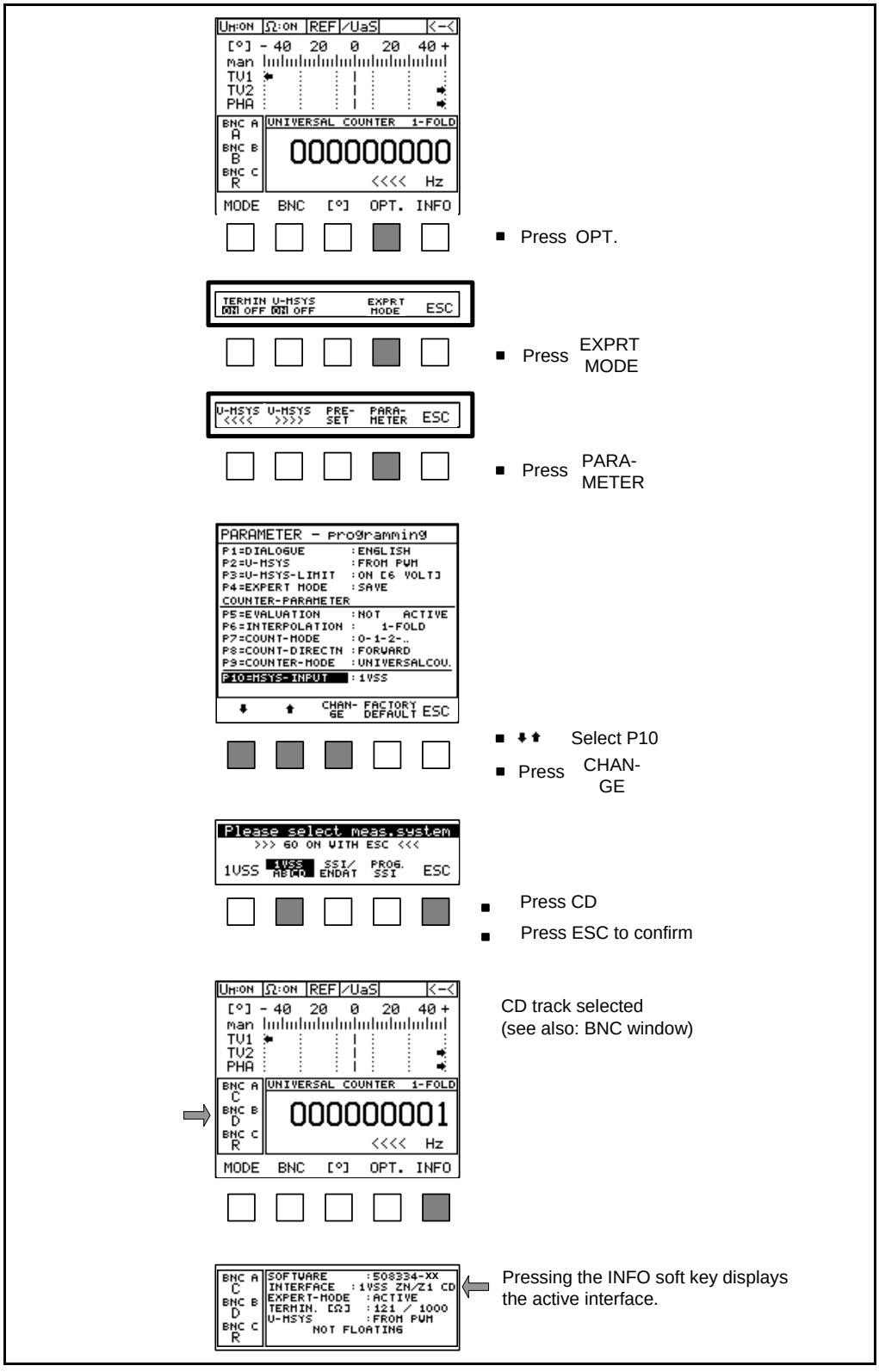
Incremental encoders without CD track that are equipped with 17-pin connectors must be checked in the "1 Vpp" setting (to avoid signal disturbances).

5.6.2 Selecting the interface via parameter

Example:
Switching from active 1 Vpp AB track to CD track

Note

This function can only be performed with active EXPERT MODE.
Activation see “Activating the EXPERT MODE" on page 100.



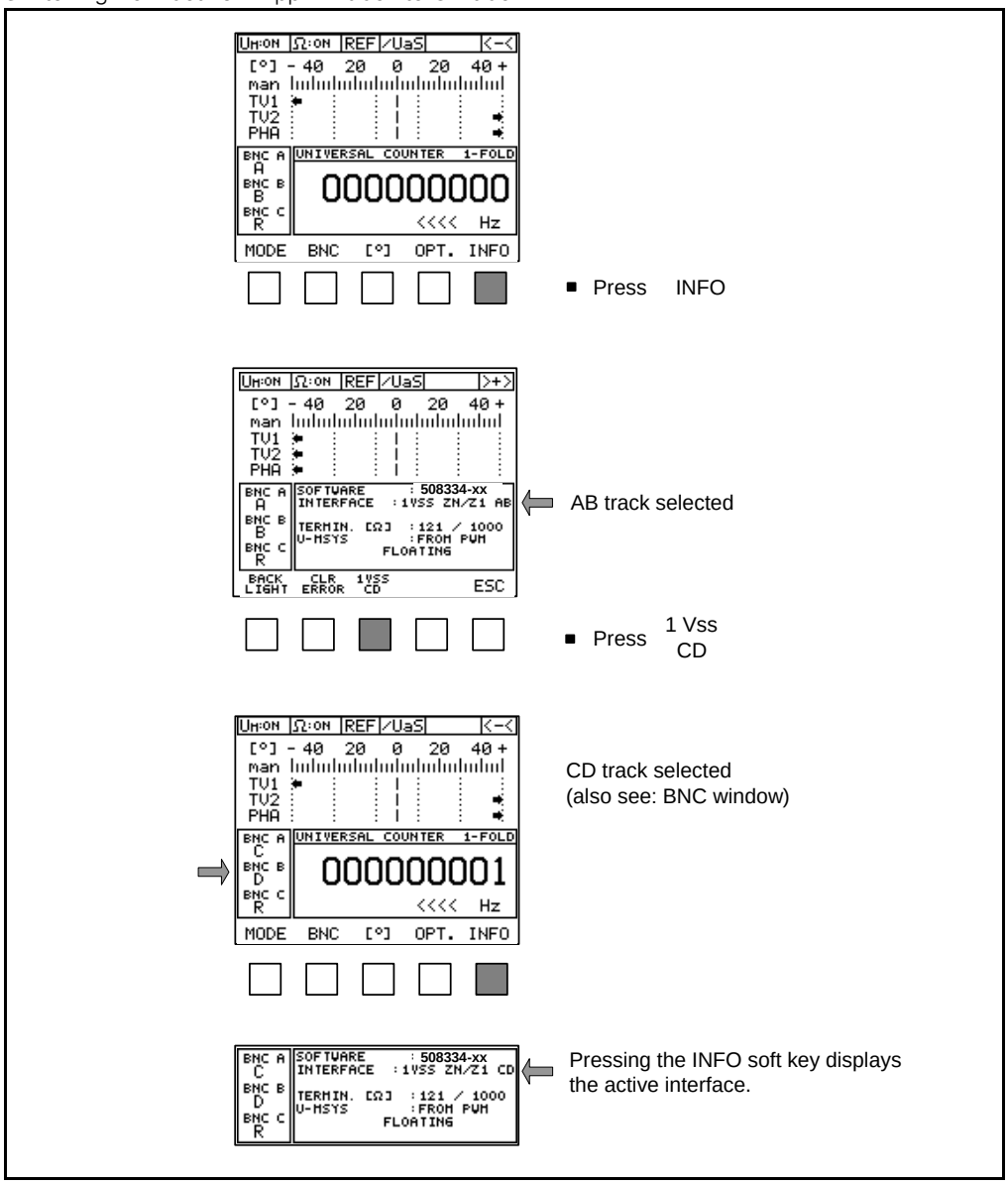
5.6.3 Fast changeover from AB to CD track

Note

AB and CD tracks only possible with 1 Vpp.

Example:

Switching from active 1 Vpp AB track to CD track



Note

Incremental encoders without CD track that are equipped with 17-pin connectors must be checked in the "1 Vpp" setting (to avoid signal disturbances).

5.6.4 Possible settings when programmable SSI interface is selected

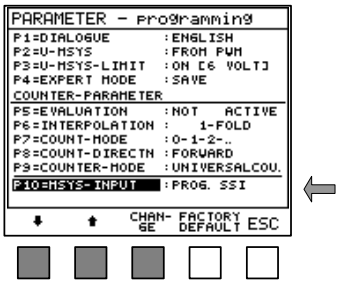
Attention

Encoder power supply 10 - 30 V!
Connecting an encoder with 5 V operating voltage will destroy the encoder electronics!

Note

After power interruption the encoder operating voltage is reset to 5 V.

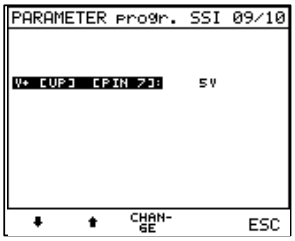
Switching to 10 - 30 V power supply



- Change to Parameter menu

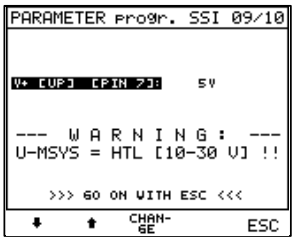
Programmable SSI interface selected

- Press all 3 keys simultaneously

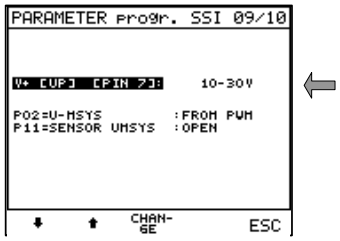


- Press CHAN-GE

Warning is displayed



- Press CHAN-GE
- Press ESC



Display changes to 10 - 30 V

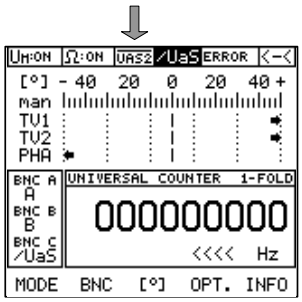
- Press ESC

12 V encoder operating voltage is now active!

Second display of interference signal with programmable SSI interface

Note

The $\overline{\text{UaS2}}$ signal is only displayed when the terminating resistor is switched on.



The encoder fault-detection signal $\overline{\text{UaS2}}$ is generated by the encoder and has nothing to do with the $\overline{\text{UaS}}$ signal from the PWM!
The encoder outputs the $\overline{\text{UaS2}}$ signal on PIN 3 and transfers it to the PWM display.

6 Activating Another PWM Measuring Mode

6.1 General Explanations of the Different Modes

Note

When being switched off, the PWM stores its current setting.

The last setting is loaded when the unit is switched on.

The EXPERT MODE is the only exception; it can be saved permanently via parameter.

PWT MODE

"Initial" mode for easy assessment of the quality and the amplitude of the output signals.

Simple diagnosis of the reference-mark signal (position and width).

Mounting aid for "exposed encoders" to optimize the parallelism of the grating and the air gap between scanning head and scale.

Note

An oscilloscope **can** be used.

PWM MODE

Inspection of analog and square-wave incremental signals by measuring TV1/2 (on-to-off ratio) and PHA (phase shift).

Detailed measurements of counting function, amplitude size and several status settings are possible in the EXPERT MODE.

Note

We recommend using an oscilloscope for signal evaluation!

EXPERT MODE

This mode provides access to the PWM status settings. Parameter settings can be changed, interpolation and preset counter values etc. set.

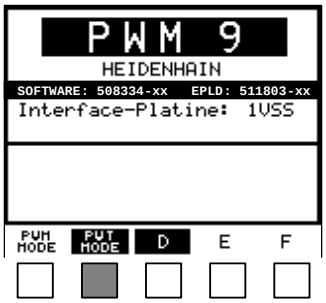
Note

The parameter range can only be changed in the PWM MODE!

6.2 Activating the PWT MODE

Note

Pressing the soft key (in PWM or PWT MODE) twice reduces the display time of the power-up screen!



Switch PWM on

While the power-on screen is displayed (for approx. 10 s) press soft key:

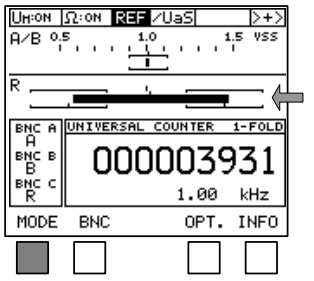
D, **E** or **F** = Language

- Select **PWT-MODE**

Note

Active functions are displayed inversely (dark).

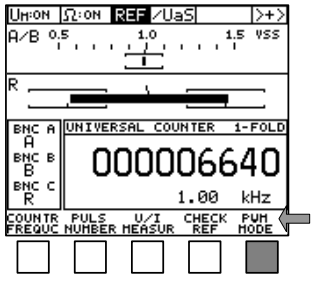
6.3 Switching from PWT MODE to PWM MODE



PWT MODE active

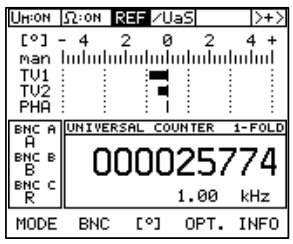
Typical display:
3 square brackets and 2 bars

- Press **MODE**



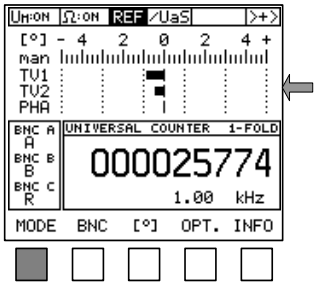
Menu bar changes its functionality!

- Select **PWM MODE**



PWM MODE active

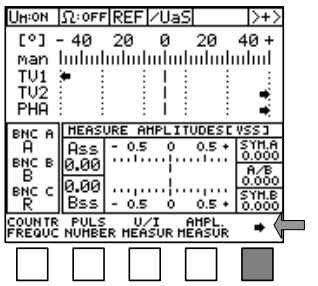
6.4 Switching from PWM MODE to PWT MODE



PWM MODE active

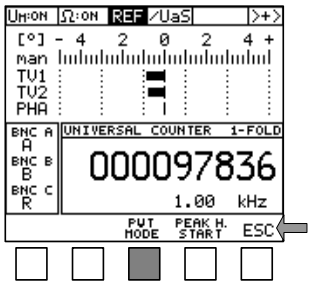
Typical display:
- Degrees [°] scaling
- Bar display of TV1/TV2 (on-to-off ratio) and PHA (phase shift)

- Press **MODE**



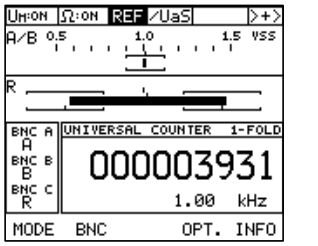
Menu bar changes its functionality!

- Press soft key to display expanded menu bar.



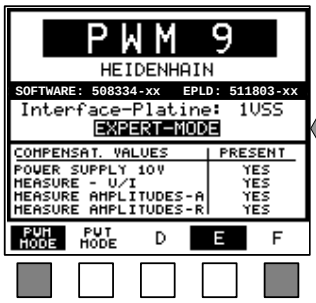
Menu bar changes its functionality!

- Press **PWT MODE**



PWT MODE active

6.5 Activating the EXPERT MODE



Active **EXPERT MODE**

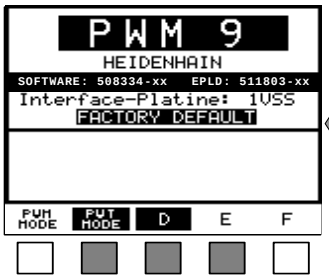
EXPERT MODE display

- Switch on PWM.
  (An interface board must be inserted!)
- **Simultaneously press the outer two soft keys** while the power-on message is displayed (for approx. 10 seconds).

Note

When the PWM was off, the EXPERT MODE has to be reactivated.
Permanent activation is possible via parameter (See "Parameter P4 = Save EXPERT MODE setting to non-volatile memory" on page 84).

6.6 Restoring the Factory Setting



Display of factory default setting

- Switch on PWM.
  (An interface board must be inserted!)
- While the power-on message is displayed (approx. 10 secs) press the **middle 3 keys at the same time.**
- Default setting is restored.

Factory setting

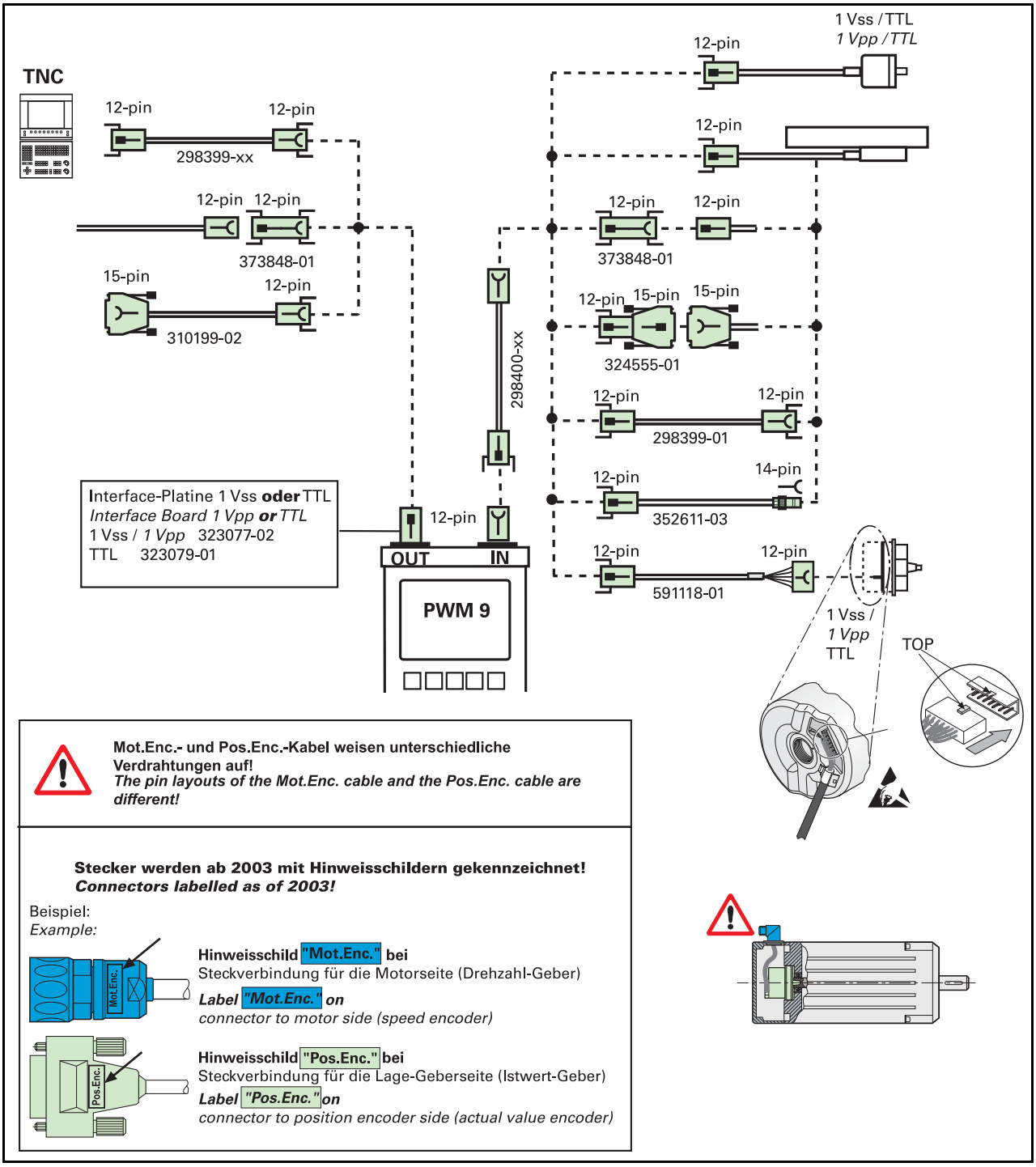
- PWT MODE (interface board: 1 Vpp, 11 µApp, 1 Vpp absolute)
- PWM MODE (interface board: TTL, HTL)
- BNC assignment see "Possible assignments of the BNC sockets" on page 55
- UNIVERSAL COUNTER
- Standard settings of the parameters

Note

The factory setting can also be restored in the parameter menu.
(See "Description of PARAMETER programming" on page 78.)

7 Overview of the Adapter Cables

7.1 1 Vpp and TTL Interface Boards



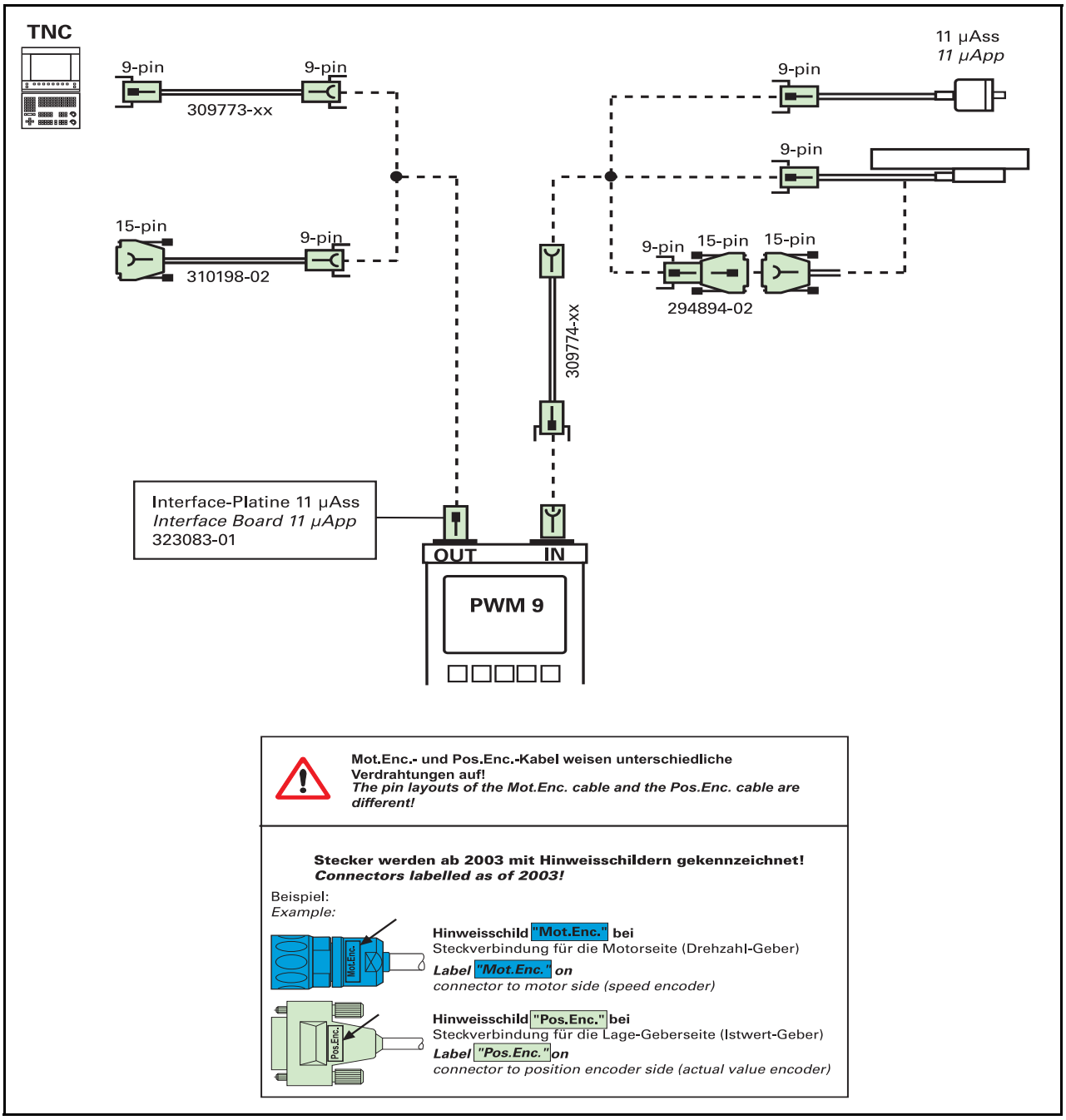
Note

The adapter cables are the same for 1 Vpp and TTL applications (identical assignments).

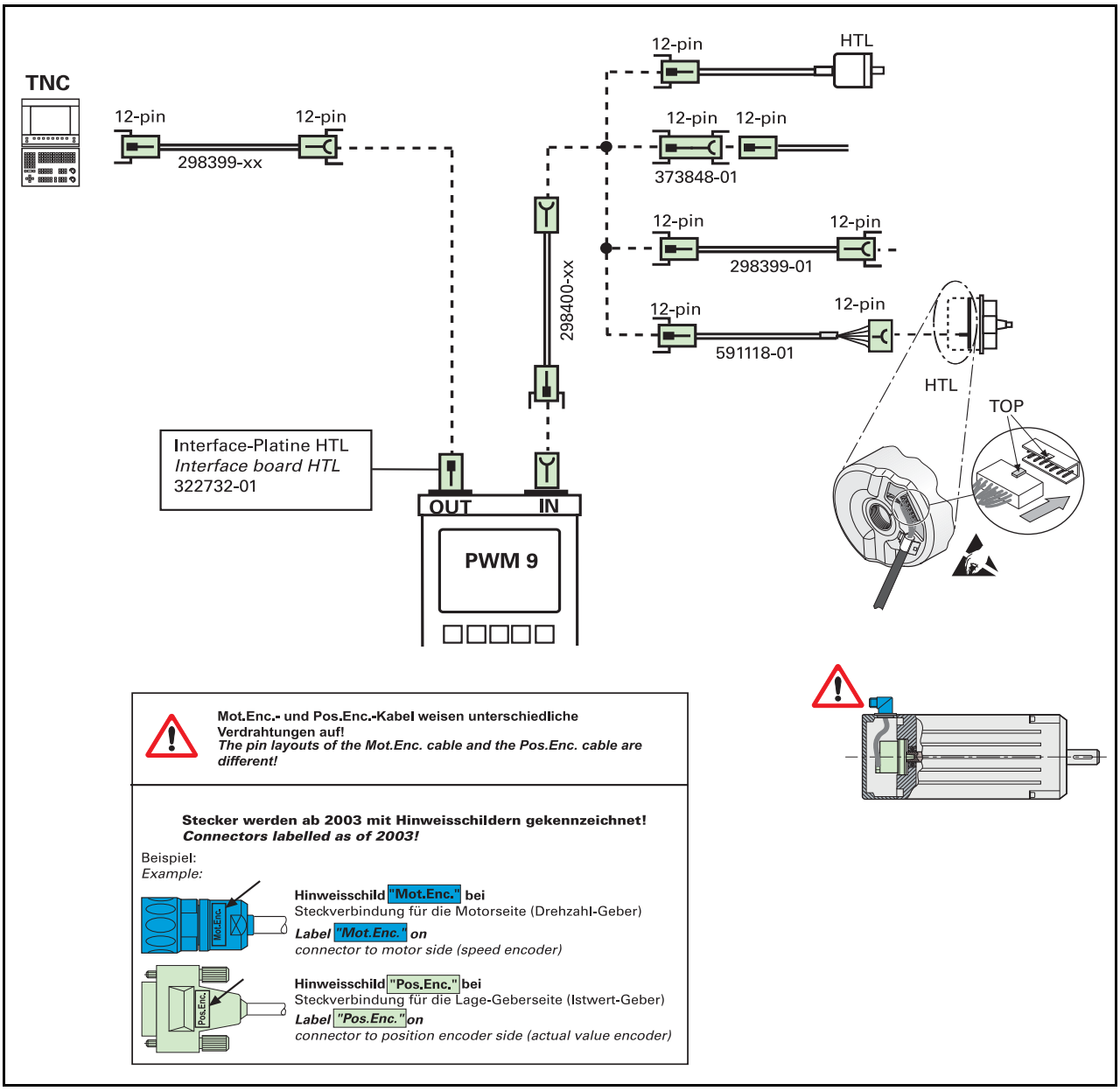
DANGER

Contact the motor manufacturer regarding the assignment of the motor flange socket (no HEIDENHAIN layout)!

7.2 11 µApp Interface Board



7.3 HTL Interface Board



Note

The adapter cables are the same for HTL and TTL applications.

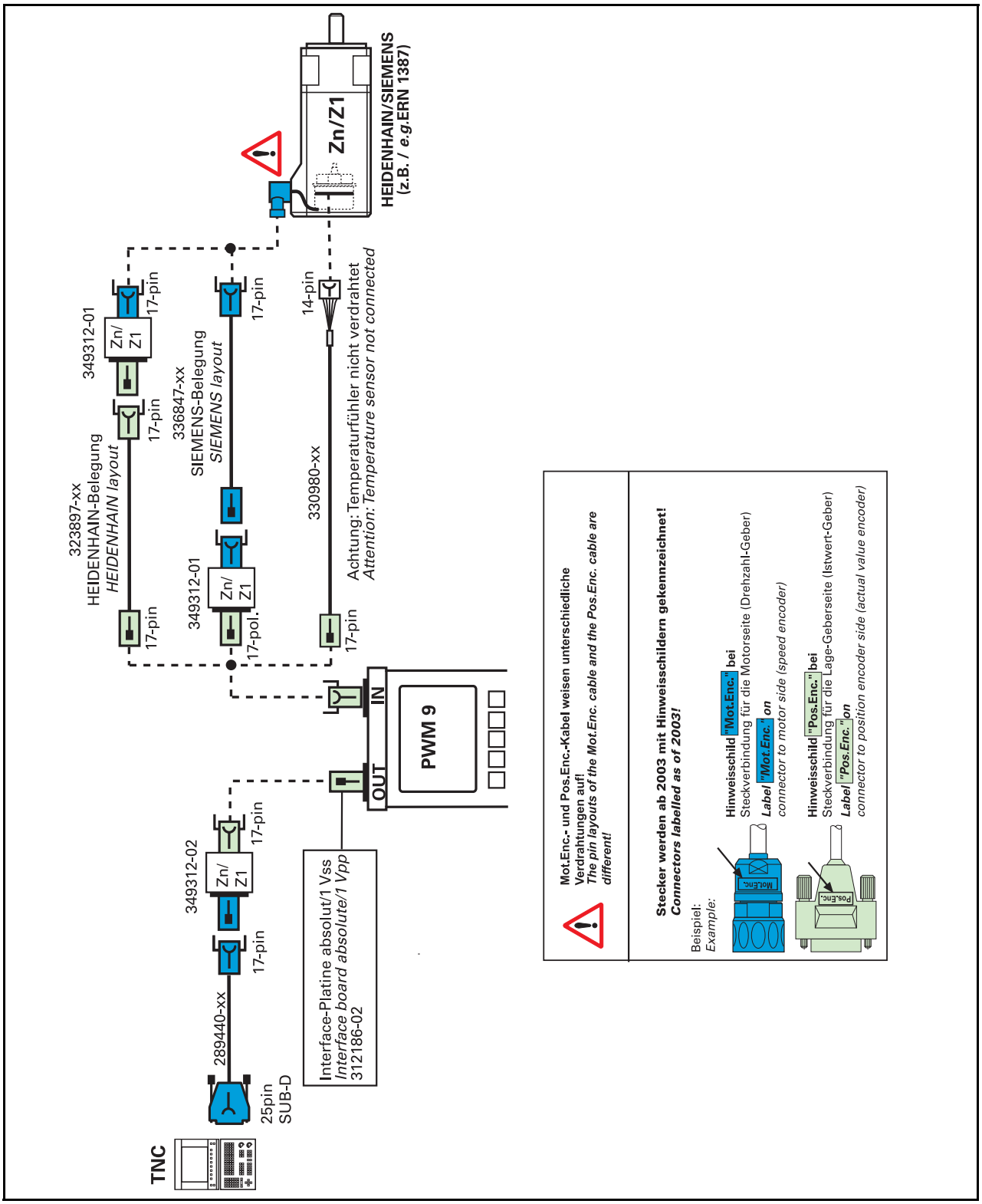
Attention

HTL operating voltage = 10 to 30 V!
TTL units (U_B = 5 V) are destroyed by HTL operating voltage!

DANGER

Contact the motor manufacturer regarding the assignment of the motor flange socket (no HEIDENHAIN layout)!

7.4 Interface Board Absolute / 1 Vpp, Sinusoidal Commutating Signal Zn/Z1



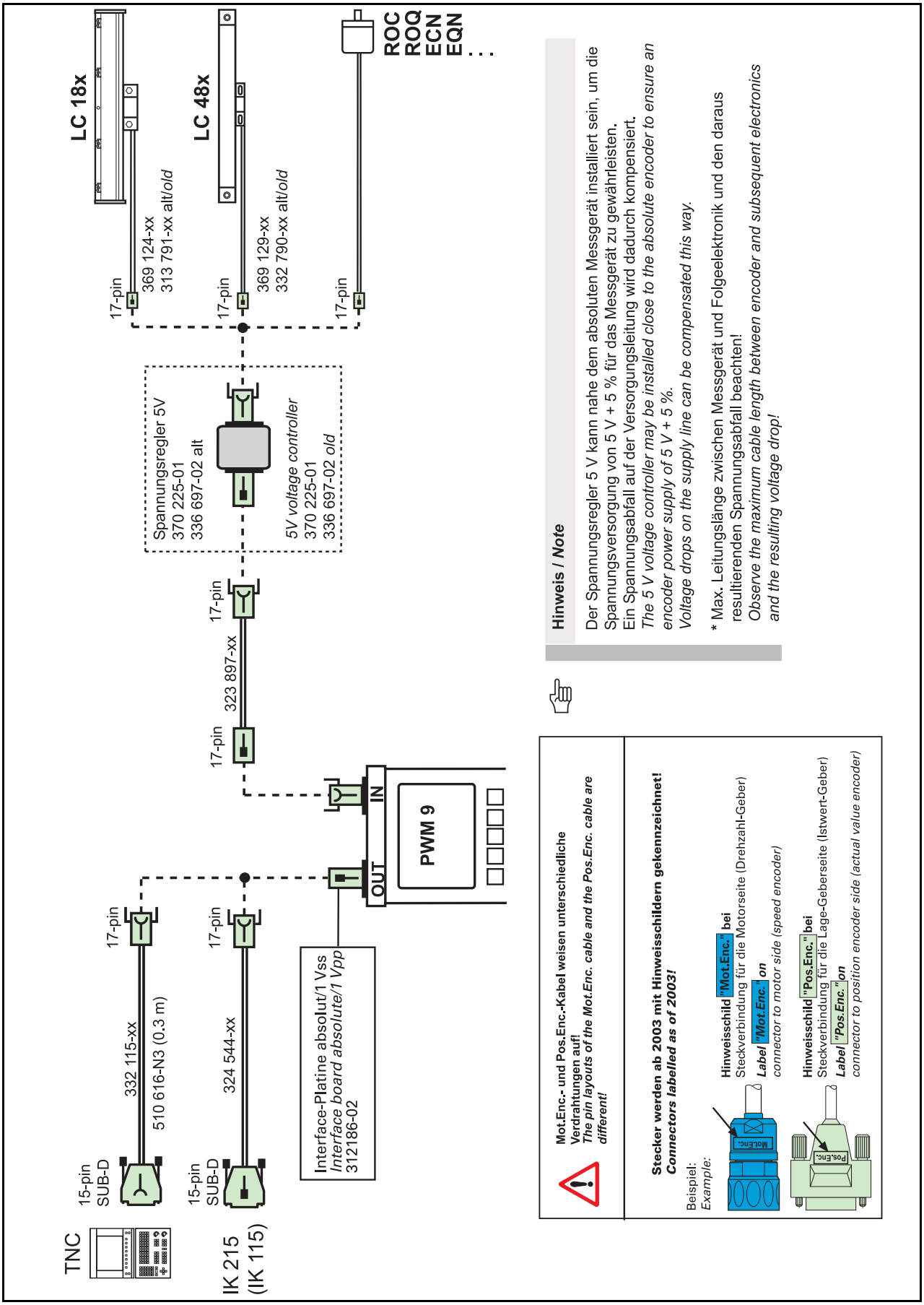
Attention

SIEMENS layout is used at the motor flange socket.
The SIEMENS layout is not compatible with the HEIDENHAIN layout!

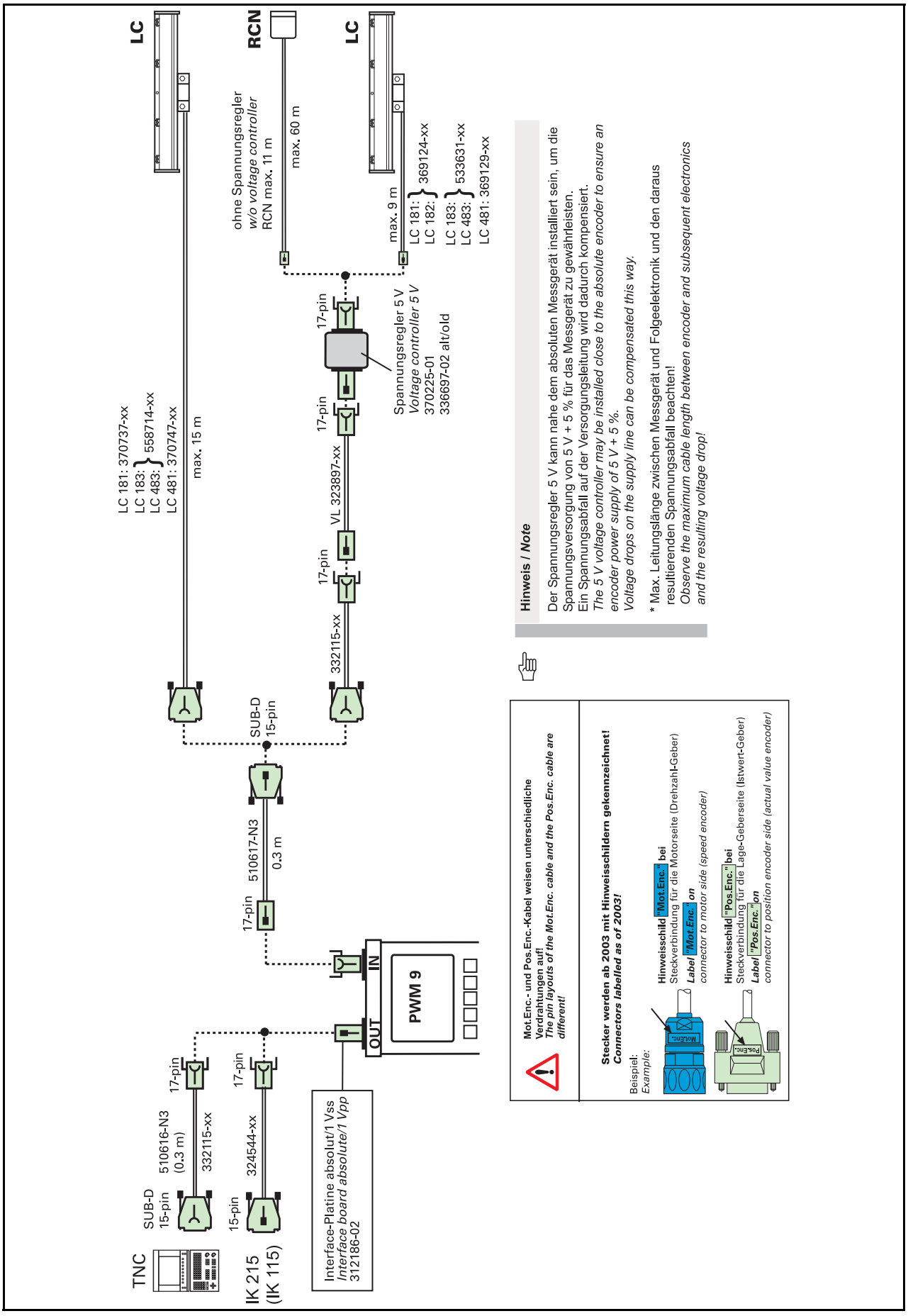
Always use the adapter connectors ID 349312-01/02!

The PWM interface board ID 312186-02 uses the HEIDENHAIN layout!

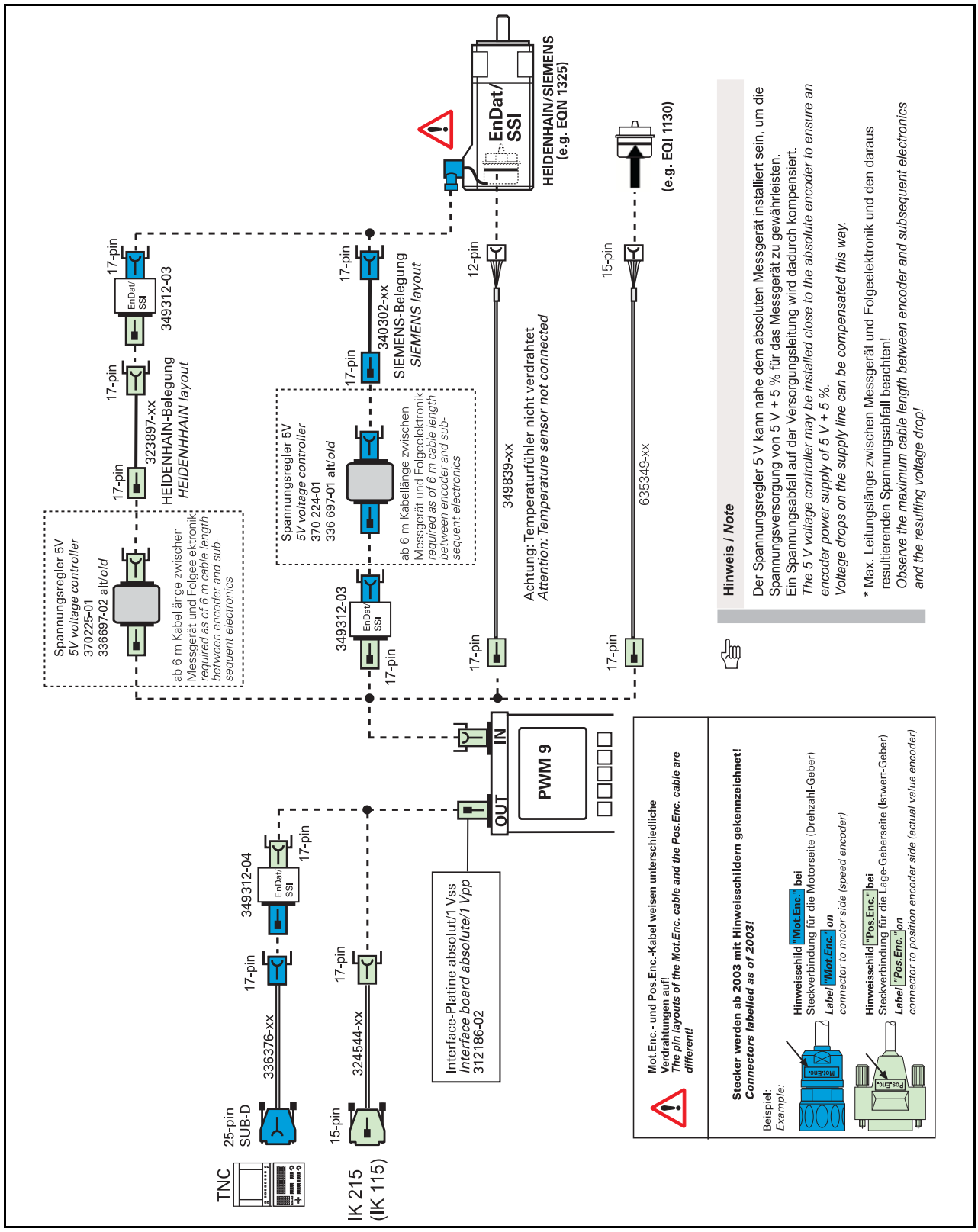
7.5 Interface Board Absolute / 1 Vpp, Encoders EnDat / SSI / SSI Programmable; Measurement of the Absolute Signals at the Encoder Side


LC 18x
LC 48x
ROC
ROQ
ECN
EQN . . .
17-pin
369 124-xx
313 791-xx alt/old
369 129-xx
332 790-xx alt/old
Spannungsregler 5V
370 225-01
336 697-02 alt
5V voltage controller
370 225-01
336 697-02 old
323 897-xx
OUT
IN
PWM 9
15-pin SUB-D
332 115-xx
510 616-N3 (0.3 m)
324 544-xx
TNC
IK 215
(IK 115)
Interface-Platine absolut/1 Vss
Interface board absolute/1 Vpp
312186-02
Mot.Enc.- und Pos.Enc.-Kabel weisen unterschiedliche Verdrahtungen auf!
The pin layouts of the Mot.Enc. cable and the Pos.Enc. cable are different!
Stecker werden ab 2003 mit Hinweisschildern gekennzeichnet!
Connectors labelled as of 2003!
Beispiel:
Example:
Hinweisschild "Mot.Enc." bei Steckverbindung für die Motorseite (Drehzahl-Geber)
Label "Mot.Enc." on connector to motor side (speed encoder)
Hinweisschild "Pos.Enc." bei Steckverbindung für die Lage-Geberseite (Istwert-Geber)
Label "Pos.Enc." on connector to position encoder side (actual value encoder)
Hinweis / Note
Der Spannungsregler 5 V kann nahe dem absoluten Messgerät installiert sein, um die Spannungsversorgung von 5 V + 5 % für das Messgerät zu gewährleisten.
Ein Spannungsabfall auf der Versorgungsleitung wird dadurch kompensiert.
The 5 V voltage controller may be installed close to the absolute encoder to ensure an encoder power supply of 5 V + 5 %.
Voltage drops on the supply line can be compensated this way.
* Max. Leitungslänge zwischen Messgerät und Folgeelektronik und den daraus resultierenden Spannungsabfall beachten!
Observe the maximum cable length between encoder and subsequent electronics and the resulting voltage drop!

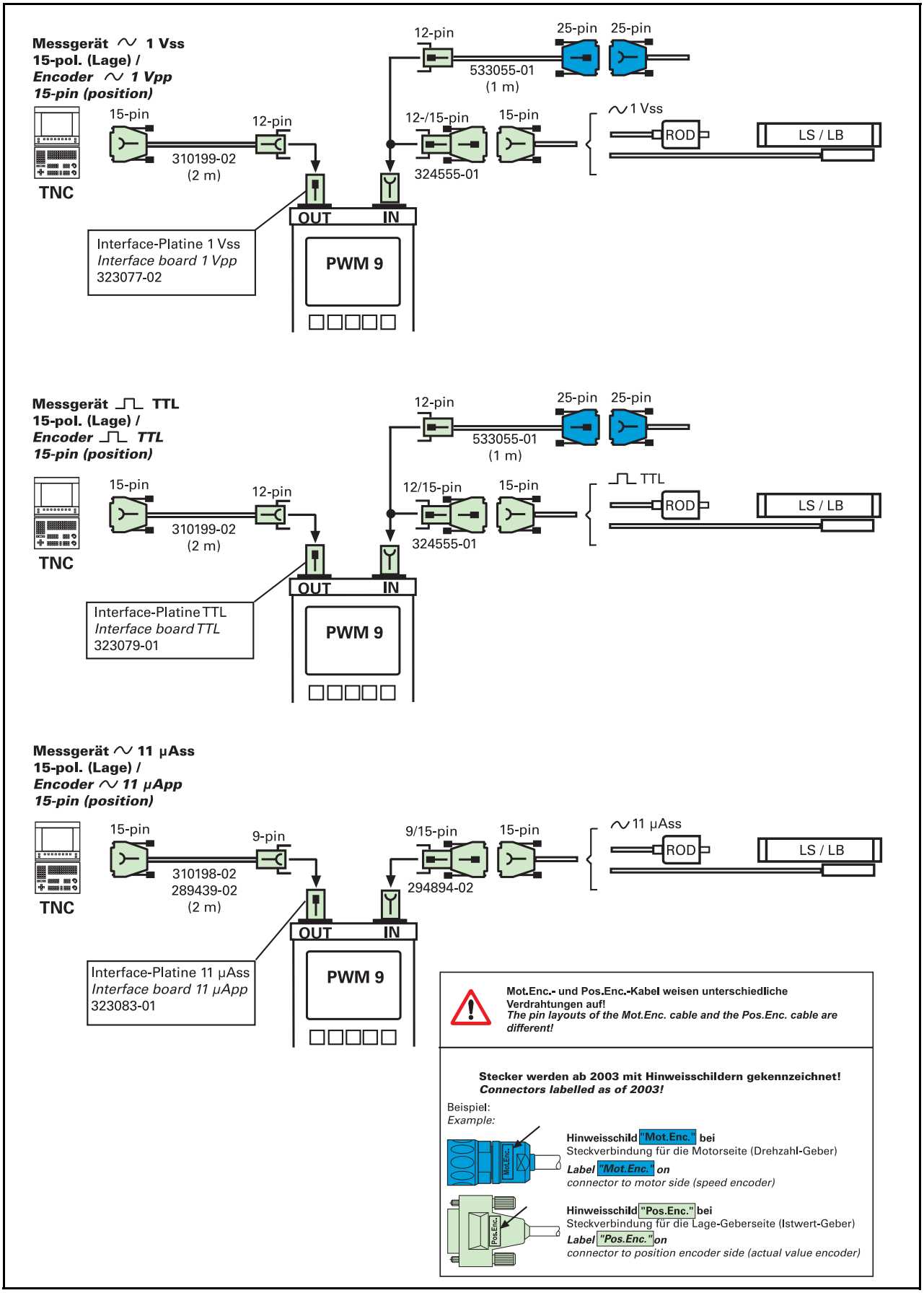
7.6 Interface Board Absolute / 1 Vpp, EnDat Encoders; Measurement at the Control Side



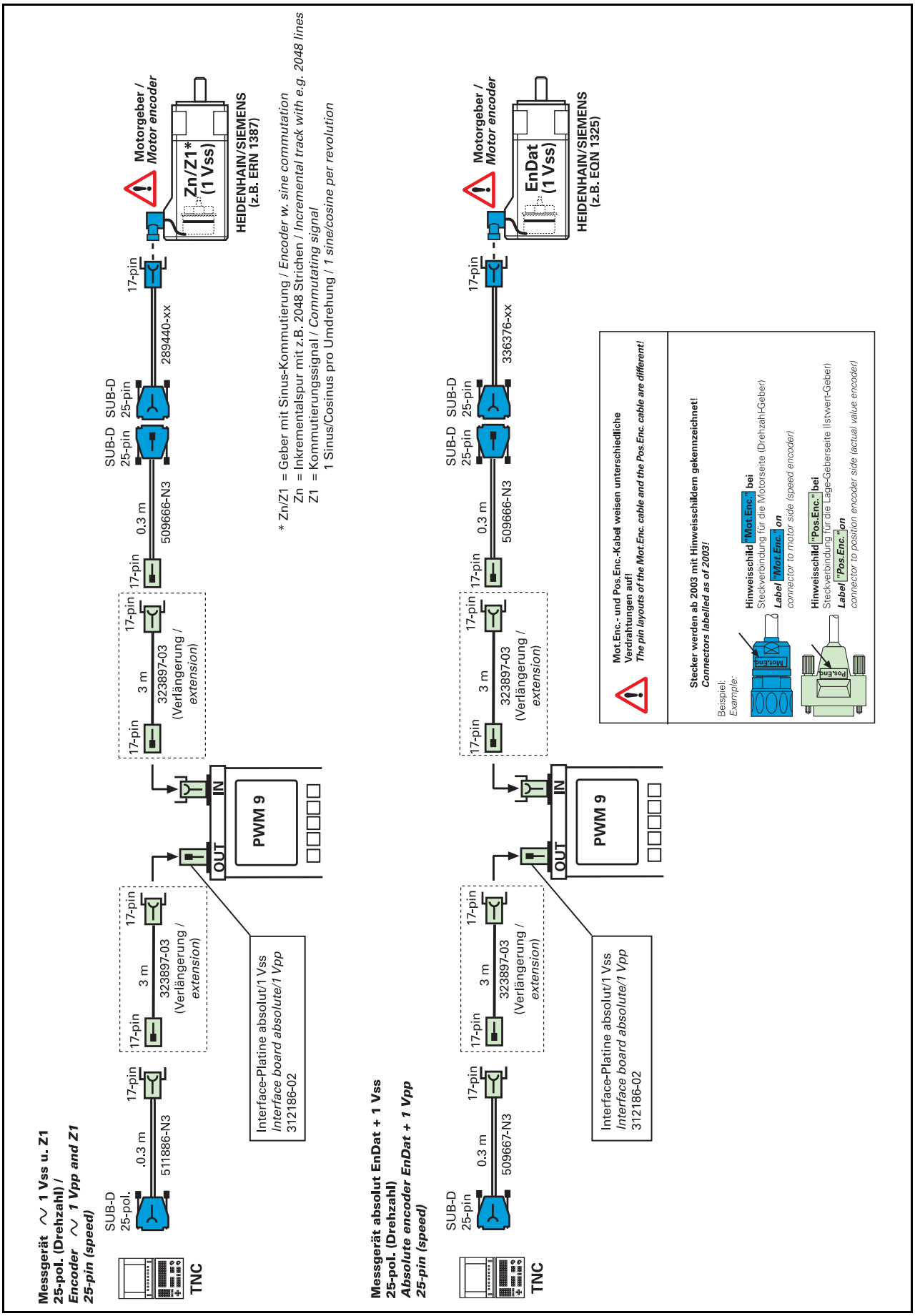
7.7 Interface Board Absolute / 1 Vpp, Motor Encoders EnDat / SSI / SSI Programmable


HEIDENHAIN/SIEMENS
(e.g. EQN 1325)
EnDat/
SSI
12-pin
349839-xx
Achtung: Temperaturfühler nicht verdrahtet
Attention: Temperature sensor not connected
15-pin
635349-xx
(e.g. EQI 1130)
17-pin
17-pin
17-pin

7.8 TNC with 15-Pin/25-Pin D-Sub Connectors and Interface Boards 1 Vpp, TTL, 11 µApp (Position Encoders)



7.9 TNC with 25-Pin D-Sub Connectors, Zn/Z1 (1 Vpp), EnDat (1 Vpp) (Motor Encoders)



Note

SIEMENS layout is used at the motor flange socket.
The SIEMENS layout is not compatible with the HEIDENHAIN layout!

Always use the adapter cables ID 509666-xx / 509667-xx / 511886-xx!

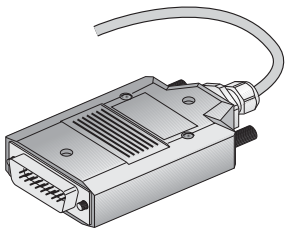
The PWM interface board ID 312186-02 uses the HEIDENHAIN layout!

7.10 Encoders with TTL --> 11 µApp Switch

Exposed measuring systems with TTL interface require a conversion of the output signals from TTL to 11 µApp to allow for precise mechanical adjustment.
The amplitude of the analog output signal and the reference mark position provide information on the mechanical position (air gap, parallelism, etc.) of the scanning head.

Encoders with APE and D-sub connectors are differentiated.

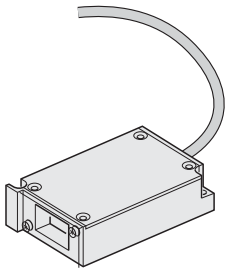
Sub-D-Stecker-Elektronik /
D-Sub electronics



Messgeräte mit Sub-D-Stecker:
Encoders with D-Sub connector:

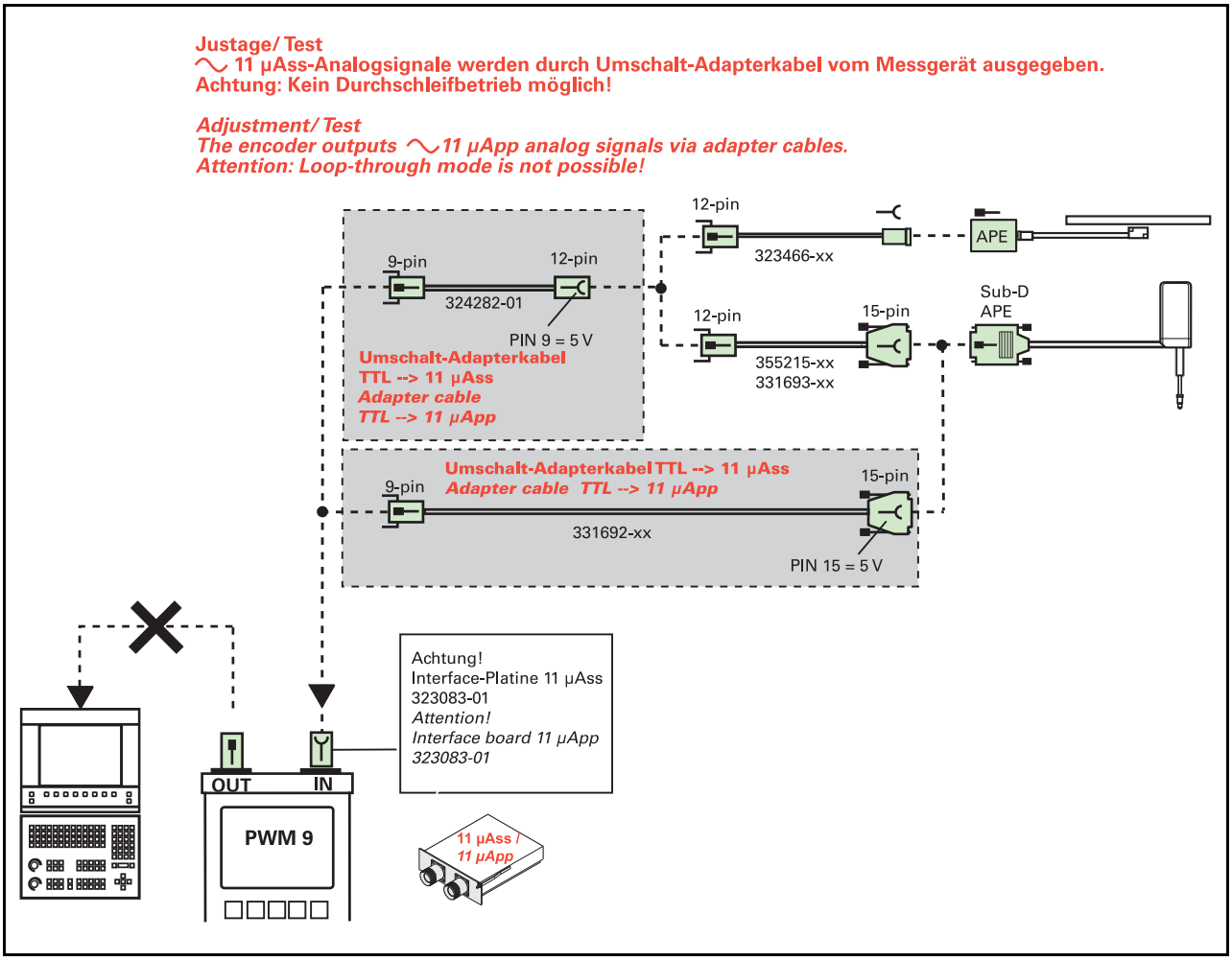
LIF 17	MT 1271
LIP 47	MT 2571
LIP 57	ST 1271
LIDA 17	ST 1277
LIDA 42	ST 3078
LIDA 47	

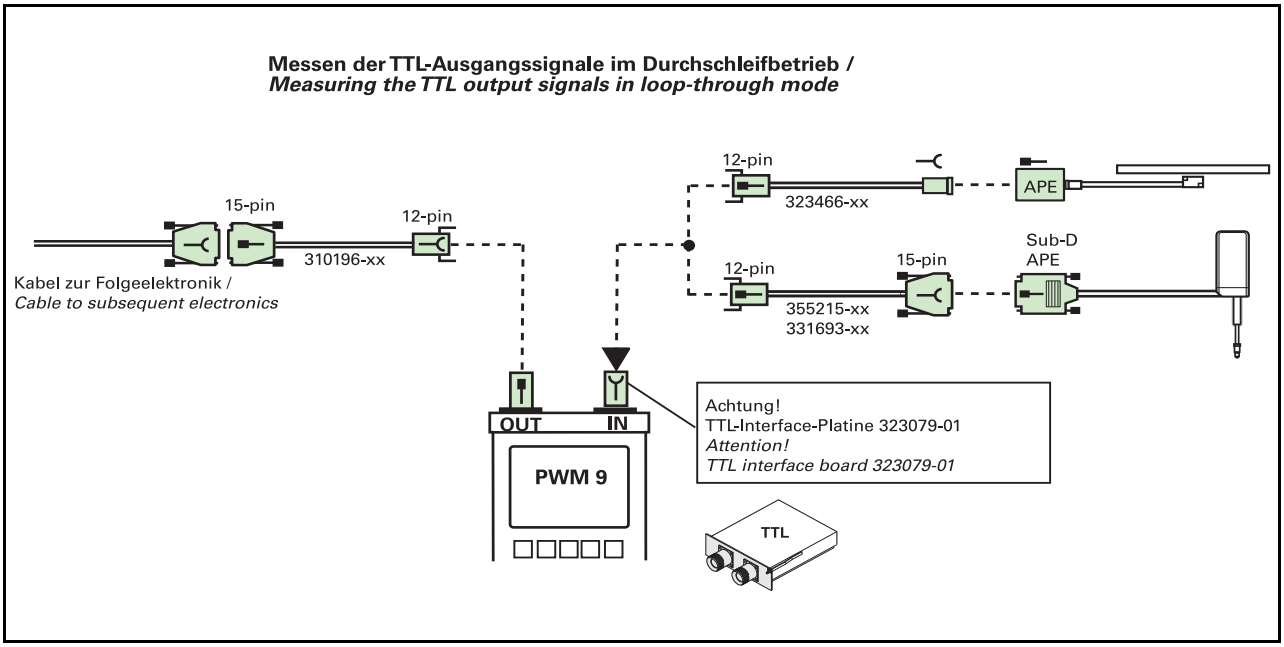
APE-Elektronik /
APE electronics



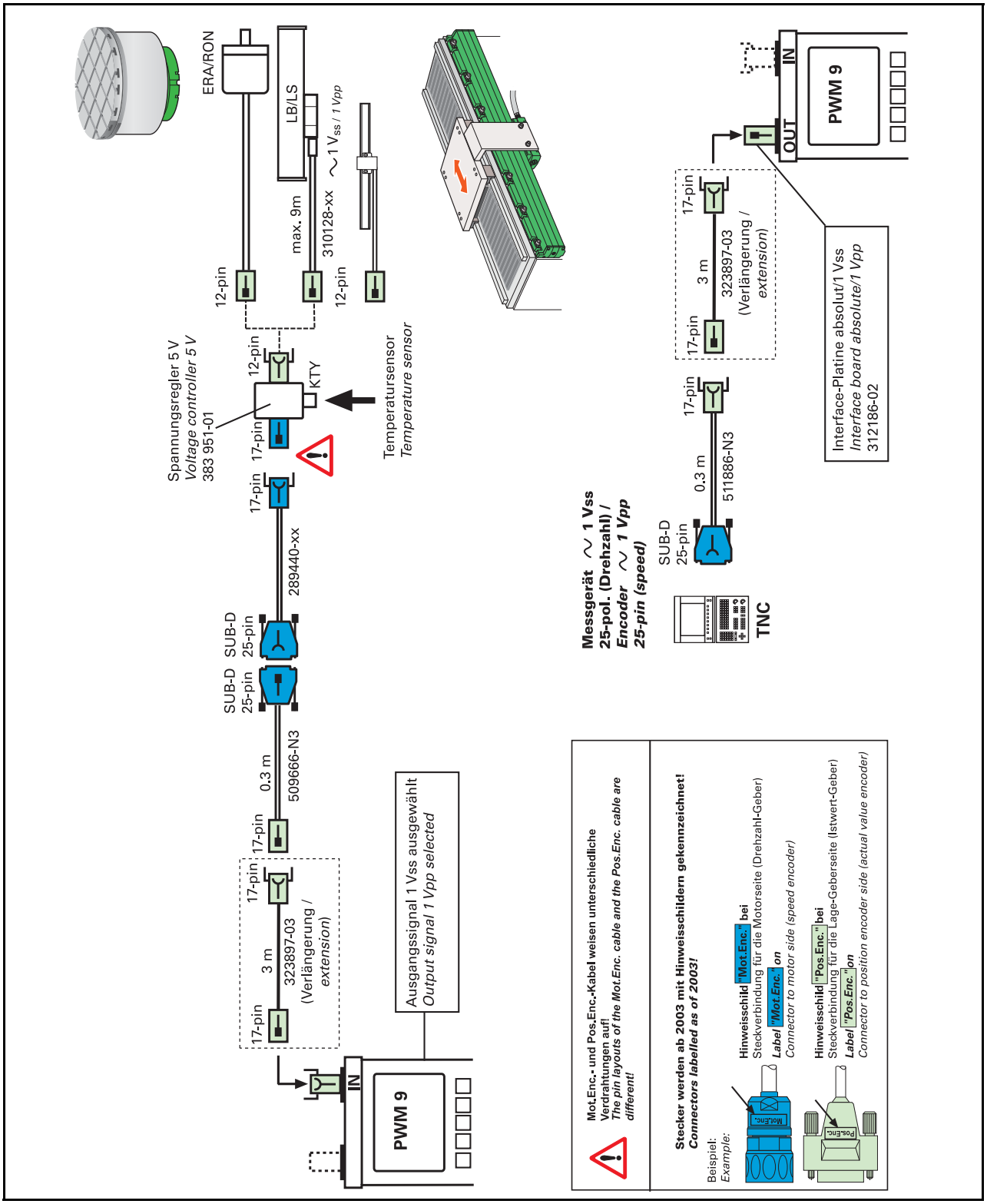
Messgeräte mit APE:
Encoders with APE:
LIF 12
LIF 17
LIP 37
LIP 47

7.10.1 Overview of TTL/11 µApp adapter cables and feed-through mode





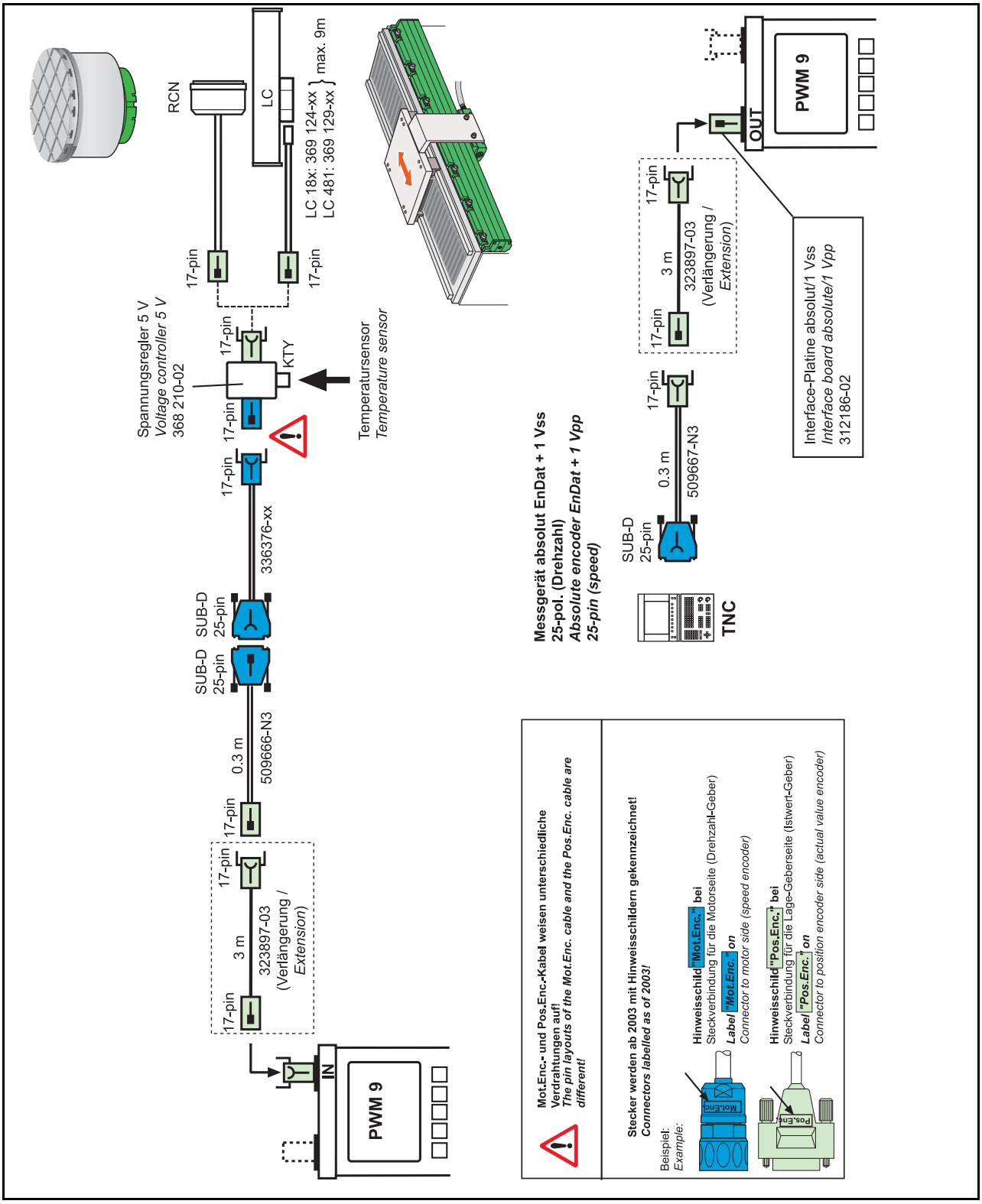
7.10.2 Overview of adapter cables: Direct drives – incremental encoders



Note

Linear or angle encoders on linear motors (direct drives) provide the actual value for both the position controller and the speed controller.
In this application the position encoders are operated at the motor controller input of the NC!

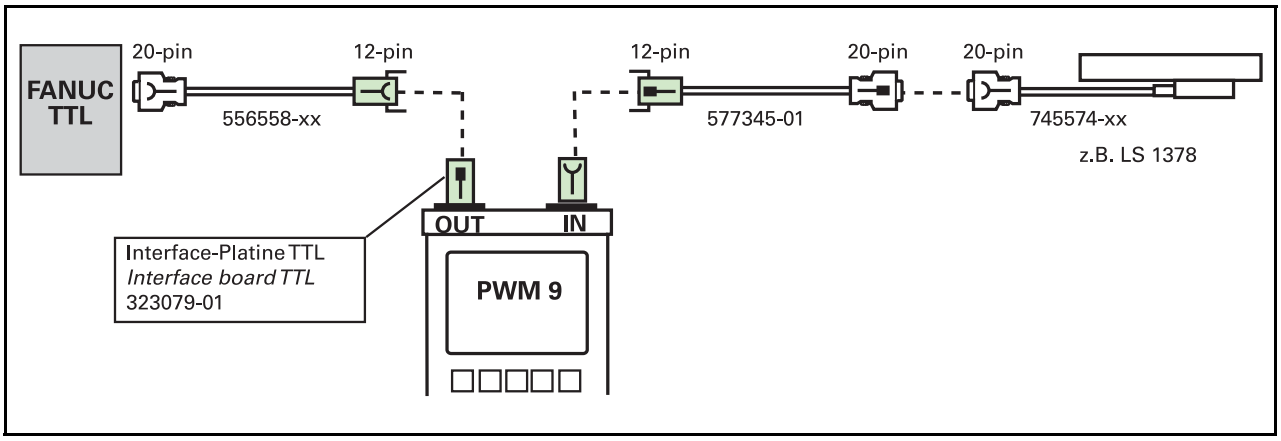
7.10.3 Overview of adapter cables: Direct drives – absolute encoders



Note

Linear or angle encoders on linear motors (direct drives) provide the actual value for both the position controller and the speed controller.
In this application the position encoders are operated at the motor controller input of the NC!

7.11 FANUC TTL Adapter



8 Interface Description

8.1 Analog Interfaces ∿

8.1.1 Incremental signals ∿ 11 µApp

Note

The stated tolerances are standard values!
The tolerances of measuring systems for high resolutions (e.g. angle encoders) and large temperature ranges (e.g. motor encoders) are tighter!
The supply voltage of 5 V ± 5% at the encoder has to be ensured!

The sinusoidal incremental signals I_1 and I_2 are phase-shifted by 90° elec. and have a signal level of 11 µApp typ. The usable component of the reference mark signals I_0 is approx. 5.5 µA. The signal sizes refer to U_P = 5 V ± 5 % at the encoder. The signal size changes with increasing scanning frequency (see Cutoff frequency).

The linear encoders with single reference marks have a reference mark every 50 mm of the glass scale, one or several of which can be activated by means of a selector magnet. The quiescent level of the output signal is increased by approximately 22 µA; the usable component G of the reference mark signal to be evaluated is based on this level. Signal peaks with amplitude G are also observed at low quiescent level with the inactive reference marks every 50 mm.

Incremental signals

2 sinusoidal current signals I_1 and I_2

Signal level M *	7 to 16 µApp typ. 11 µApp
Asymmetry $\lvert P - N \rvert / 2M$	0.065 $\hat{=}$ TV ± 15°
Signal ratio M (I_1) / M (I_2)	0.8 to 1.25
Phase angle $\lvert \varphi 1 + \varphi 2 \rvert / 2$	90° ± 10° elec.

* Old LS series
LS 50x; LS 80x (e.g. LS 503, LS 803) Ie1, Ie2 15 ... 35 µApp

Reference mark signal

1 or several signal peaks I_0

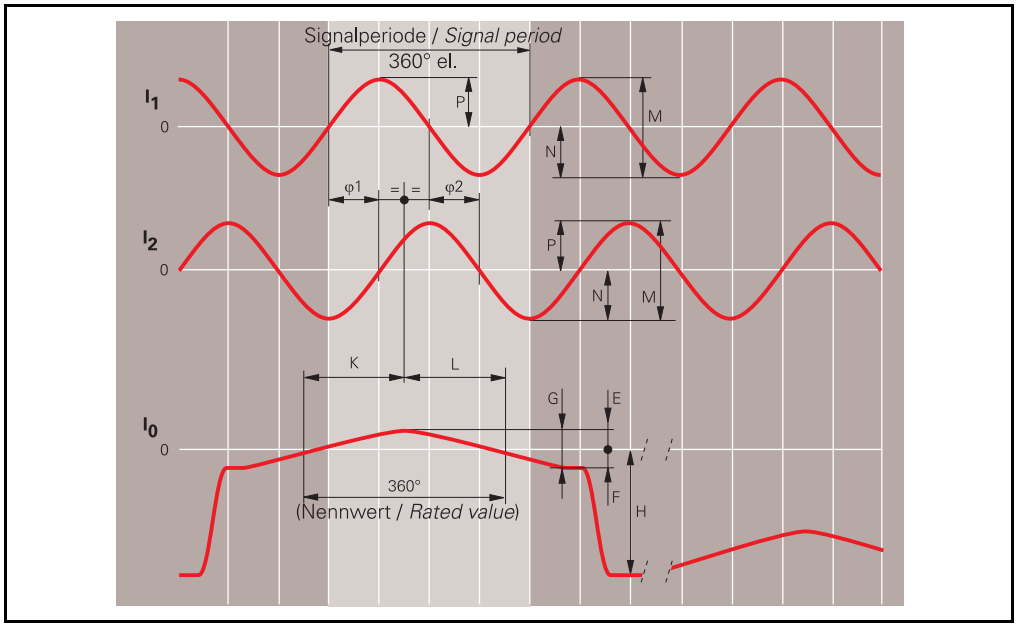
Usable component G*	2 to 8.5 µA
Quiescent value H	max. 25 µA
Signal-to-noise ratio E, F	min. 0.4 µA
Zero crossovers K, L	180° ± 90° elec.

* Old LS series
LS 50x; LS 80x (e.g. LS 503, LS 803) Ie0 4 ... 15 µA

Connecting cable

Shielded HEIDENHAIN cable	PUR [3(2 x 0.14 mm^2) + (2 x 1 mm^2)]
Cable length	max. 30 m with 90 pF/m distributed capacitance

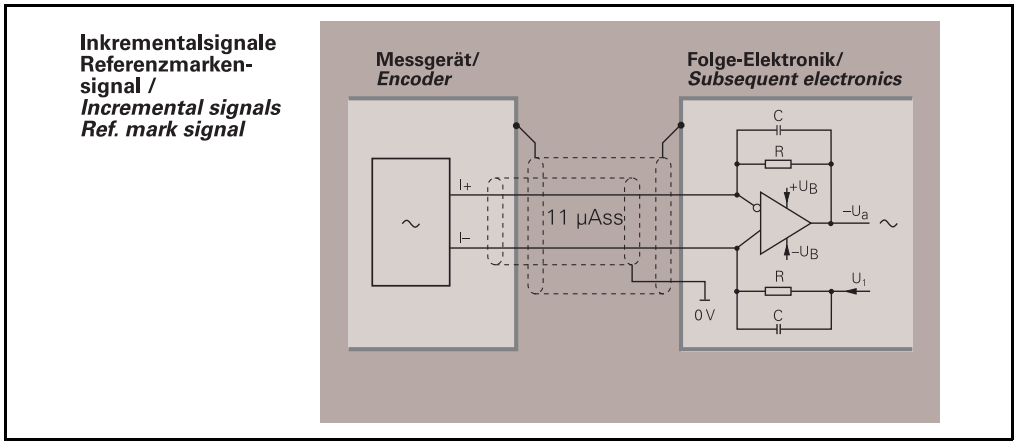
Signal diagram: Incremental signals ∿ 11 µApp



Recommended input circuit of the subsequent electronics ∿ 11 µApp

Dimensioning

Operational amplifier e.g. RC 4157
R = 100 k Ω ± 2 %
C = 27 pF
U_B = ± 15 V
U_1 = typ. 2.5 V



–3 dB cutoff frequency of the circuit

Approx. 60 kHz

Circuit output signals

$|U_a| = |I_{pp}| \times 2R$

U_a = typ. 2.2 Vpp

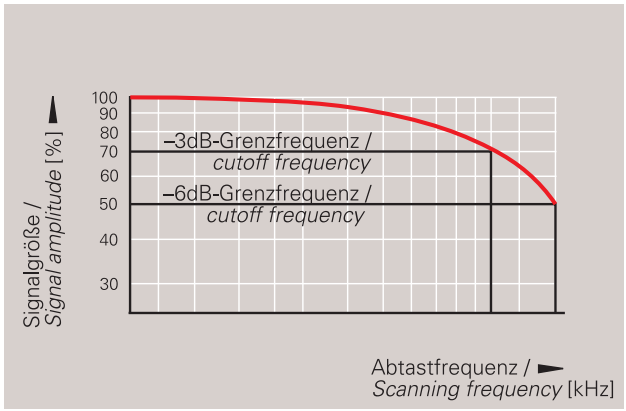
Signal monitoring

A threshold of 2.5 µApp is to be provided for the monitoring of the output signals.

Cutoff frequency

The cutoff frequency indicates the scanning frequency at which a certain fraction of the original signal size is maintained.

- –3 dB cutoff frequency: 70 % of the signal amplitude
- –6 dB cutoff frequency: 50 % of the signal amplitude



Typischer Verlauf der Signalgröße abhängig von der Abtastfrequenz /
Typical amplitude progression as a function of the scanning frequency

8.1.2 Incremental signals ∿ 1 Vpp

Note

The stated tolerances are standard values!
The tolerances of measuring systems for high resolutions (e.g. angle encoders) and large temperature ranges (e.g. motor encoders) are tighter!
The supply voltage of 5 V ± 5% at the encoder has to be ensured!

The **sinusoidal incremental signals A and B** are phase-shifted by 90° elec. and have a signal amplitude of 1 Vpp typ. The usable component of the **reference mark signals R** is approximately 0.5 V. The values for the signal amplitudes apply for Up = 5 V ± 5 % at the encoder (see Encoder specifications) and refer to a differentiation measurement at a 120 Ω terminating resistor between the related outputs. The signal size changes with increasing scanning frequency.

The linear encoders with single reference marks have a reference mark every 50 mm of the glass scale, one or several of which can be activated by means of a selector magnet. The quiescent level of the output signal is increased by approximately 1.5 V; the usable component G of the reference mark signal to be evaluated is based on this level. Signal peaks with amplitude G are also observed at low quiescent level with the inactive reference marks every 50 mm.

Incremental signals

2 sinusoidal signals A and B

Signal amplitude M	0.6 to 1.2 Vpp typ. 1 Vpp
Recommended lower threshold sensitivity for signal monitoring	min. 0.3 V
Recommended upper threshold sensitivity for signal monitoring	max. 1.35 V
Asymmetry $\lvert P - N \rvert / 2M$	0.065 ≙ TV ± 15°
Signal ratio M_A / M_B	0.8 to 1.25
Phase angle $\lvert \varphi 1 + \varphi 2 \rvert / 2$	90° ± 10° elec.

Reference mark signal

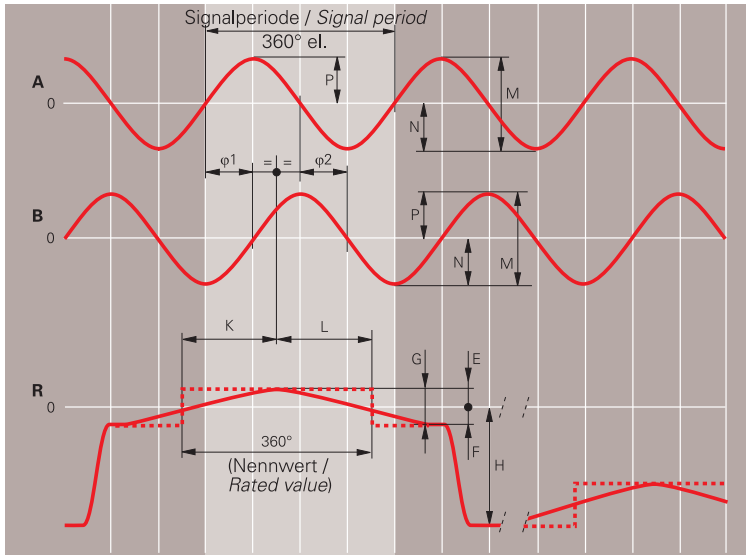
One or several signal peaks R

Usable component G	0.2 to 0.85 V
Quiescent value H	max. 1.7 V
Signal-to-noise ratio E, F	min. 40 mV, max. 680 mV
Zero crossovers K, L	180° ± 90° elec.

Connecting cable

Shielded HEIDENHAIN cable	PUR [4(2 x 0.14 mm^2) + (4 x 0.5 mm^2)]
Cable length	Max. 150 m at 90 pF/m distributed capacitance
Propagation time	6 ns/m

Signal diagram: Incremental signals ⌒ 1 Vpp



A, B, R gemessen mit Oszilloskop in Differenzbetrieb /
A, B, R measured with oscilloscope in differential mode

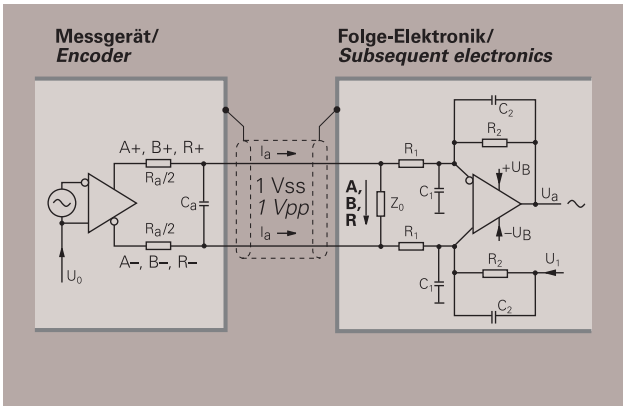
Recommended input circuit of the subsequent electronics ~ 1 Vpp

Dimensioning

Operational amplifier e.g. MC 34074; RC 4157
R_1 = 10 k Ω and C_1 = 100 pF
R_2 = 34.8 k Ω and C_2 = 10 pF
Z_0 = 120 Ω
U_B = ± 15 V
U_1 approx. U_0

Inkrementalsignale
Referenzmarken-signal /
Incremental signals
Ref. mark signals

R_a < 100 Ω , typ 24 Ω
C_a < 50 pF
ΣI_a < 1 mA
U_0 = 2,5 V ± 0,5 V
(bezogen auf 0 V der Spannungsversorgung / *referenced to 0 V of power supply*)



–3 dB cutoff frequency of the circuit

Approx. 450 kHz
Approx. 50 kHz with C_1 = 1000 pF and C_2 = 82 pF

(Recommended for electronics that are sensitive to electro-magnetic interference)

Note

This variant does reduce the bandwidth of the circuit, but in doing so it improves its noise immunity.

Circuit output signals

U_a = 3.48 Vpp typ.
3.48-fold amplification

Signal monitoring

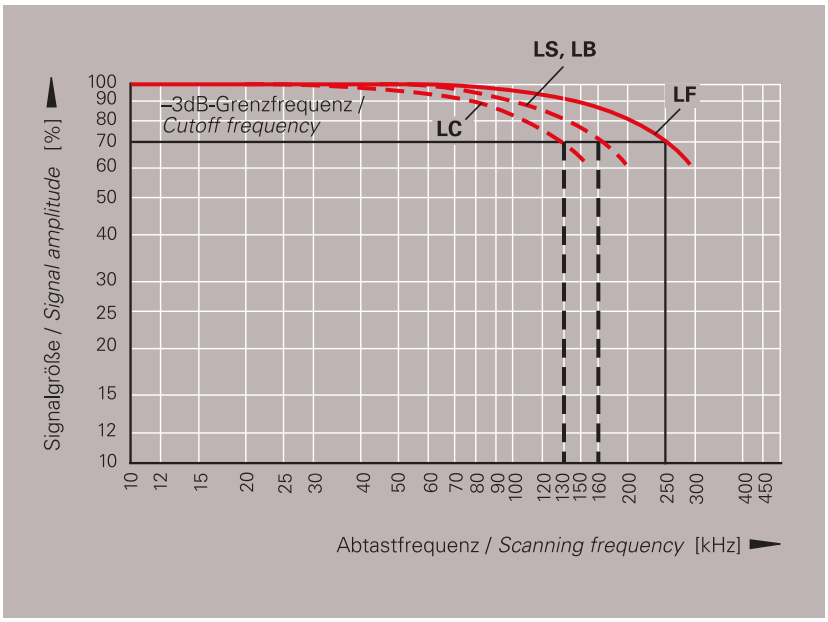
A threshold of 250 mVpp is to be provided for the monitoring of the output signals.

Signal amplitude

With measuring systems with sinusoidal output signals the signal amplitude depends on the supply voltage and therefore on the voltage drop ΔU as well as on the cutoff frequency.

Cutoff frequency

The –3dB cutoff frequency specifies at which scanning frequency about 70% of the original signal amplitude are obtained.



Typischer Verlauf der Signalgröße für sinusförmige Ausgangssignale (1 Vss) abhängig von der Abtastfrequenz /
Typical amplitude progression for sinusoidal output signals (1 Vpp) as a function of the scanning frequency

8.1.3 Incremental signals ∿ 1Vpp with commutating signals

Examples of encoders

ERN 1085, ERN 1185, ERN 1387

Commutating signals

The **commutating signals C and D** are derived from the Z1 track and represent one sine or cosine period per revolution. Their typical signal size is 1 Vpp (signal level: see incremental signals A and B). The recommended input circuit of the subsequent electronics corresponds to the 1 Vpp interface.

Incremental signals

2 sinusoidal signals A and B

Signal amplitude M	0.75 to 1.2 Vpp typ. 1 Vpp
Asymmetry $\|P - N\| / 2M$	0.05 $\hat{=}$ TV ± 11.5°
Signal ratio M_A / M_B	0.9 to 1.1
Phase angle $\|\varphi 1 + \varphi 2\| / 2$	90° ± 5° elec.

Reference mark signal

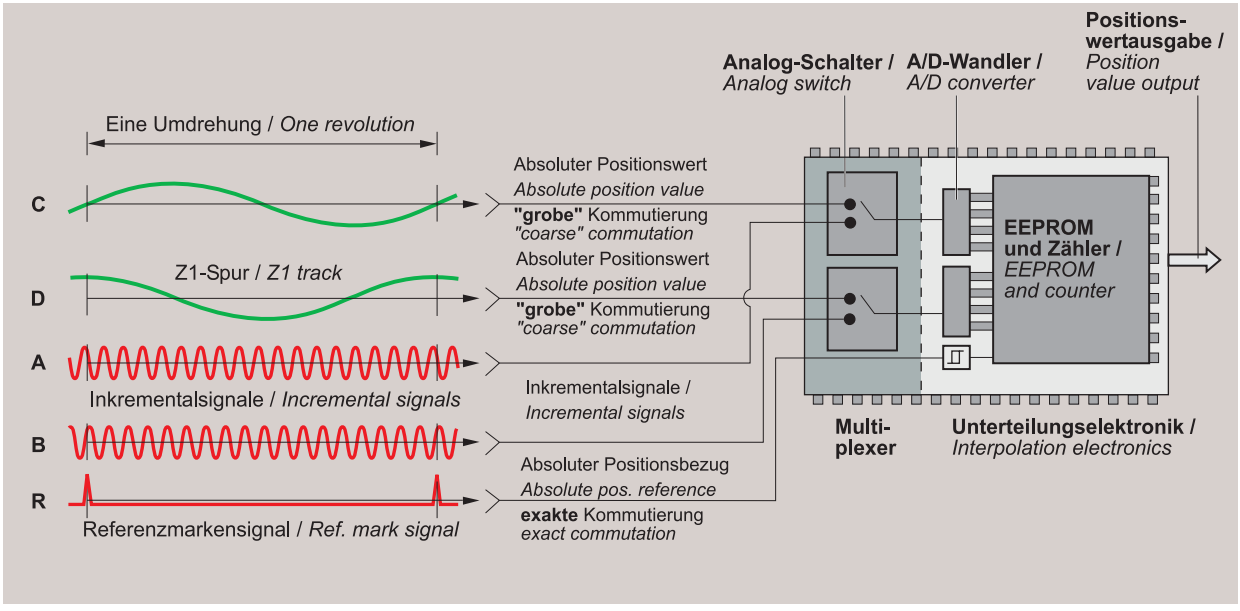
One or several signal peaks R

Usable component G	0.2 to 1.1 V
Signal-to-noise ratio E, F	min. 100 mV
Zero crossovers K, L	180° ± 90° elec.

Connecting cable

Shielded HEIDENHAIN cable	PUR [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	Max. 150 m at 90 pF/m distributed capacitance
Propagation time	6 ns/m

Elektronische Kommutierung mit Z1-Spur / *Electronic commutation with Z1 track*



8.2 Square-Wave Interfaces ⊓⊔

8.2.1 Incremental signals ⊓⊔ TTL with square-wave interface

Note

The stated tolerances are standard values!
The tolerances of measuring systems for high resolutions (e.g. angle encoders) and large temperature ranges (e.g. motor encoders) are tighter!
The supply voltage of 5 V ± 5% at the encoder has to be ensured!

Encoders that output TTL square-wave signals feature electronics which digitize the sinusoidal scanning signals without or with 2-fold interpolation. Available output signals are two **square-wave pulses Ua1and Ua2** , phase-shifted by 90° elec. as well as the **reference pulse Ua0** gated with the incremental signals. The **fault-detection signal $\overline{\text{UaS}}$** indicates fault conditions such as breakage of the power line or failure of the light source. It can be used for such purposes as machine shut-off during automated production. The integral electronics outputs the **inverted signals** of all square-wave pulse trains.

The **measuring step** results from the spacing between two edges of the signals Ua1 and Ua2 subsequent to 1-fold, 2-fold or 4-fold evaluation.

The subsequent electronics must be designed such that it captures every edge of the square-wave pulses. The minimum **edge separation a** stated in the specifications applies for the specified input circuit with a cable length of 1 m and refers to a measurement at the output of the differential line receiver. Cable-dependent differences in the propagation times additionally reduce the edge separation by 0.2 ns per meter of cable. To avoid counting errors, the subsequent electronics must be designed such that it can operate with 90% of the resulting edge separation. The maximum permissible **shaft speed** or **traversing speed** must not be exceeded even for a short period.

Examples of encoders

ERN 120, ERN 420/460, ERN 1020, ROD 42x, ROD 466, ROD 1020
LS 176, LS 476, LS 477, LS 323, LS 623, LIM 571

Incremental signals

Two 2 TTL square-wave signals Ua1 and Ua2 and their inverted signals $\overline{\text{Ua1}}$ and $\overline{\text{Ua2}}$

Edge separation	a $\geq$ 0.45 µs at 300 kHz scanning frequency
	a $\geq$ 0.8 µs at 160 kHz scanning frequency
	a $\geq$ 1.3 µs at 100 kHz scanning frequency

Reference mark signal

One or several square-wave pulses Ua0 and their inverted pulses $\overline{\text{Ua0}}$

Pulse width	90° elec. (other widths available on request) LS 323: ungated (= 360° elec.)
Delay time	$\lvert t_d \rvert \leq$ 50 ns

Fault-detection signal

(LS 176, LS 47x) **1 square-wave pulse $\overline{\text{UaS}}$**	Interference: LOW (on request: Ua1/Ua2 highly resistive) Proper function: HIGH ts $\geq$ 20 ms

Signal data

Differential line driver as per EIA standard RS-422	
Signal levels	$U_H \geq$ 2.5 V with $-I_H$ = 20 mA $U_L \leq$ 0.5 V with I_L = 20 mA
Permissible load	R $\geq$ 100 Ω (between associated outputs)
Max. load per output	$\lvert I_L \rvert \leq$ 20 mA
Capacitive load	$C_{load} \leq$ 1000 pF with respect to 0 V
Short-circuit stability	Outputs protected against short circuit to 0 V
Switching times (10 % to 90 %) with 1 m cable and recommended input circuit	Rise time $t_+ \leq$ 30 ns Fall time t– $\leq$ 30 ns

Connecting cable

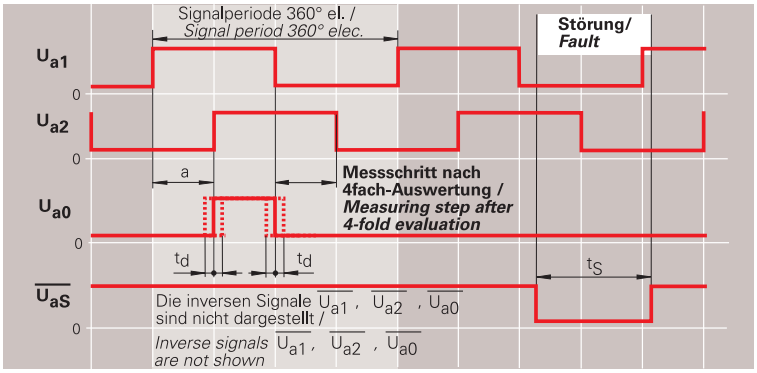
Shielded HEIDENHAIN cable	PUR [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	Max. 100 m ($\overline{UaS}$ max. 50 m) with 90 pF/m distributive capacitance
Propagation time	6 ns/m

Inkrementalsignale/
Incremental signals

U_{a2} nacheilend zu U_{a1} bei Rechtsdrehung (auf Flansch gesehen)/
U_{a2} lagging U_{a1} with ccw rotation (view onto flange)

Referenzmarkensignal/
Ref. mark signal

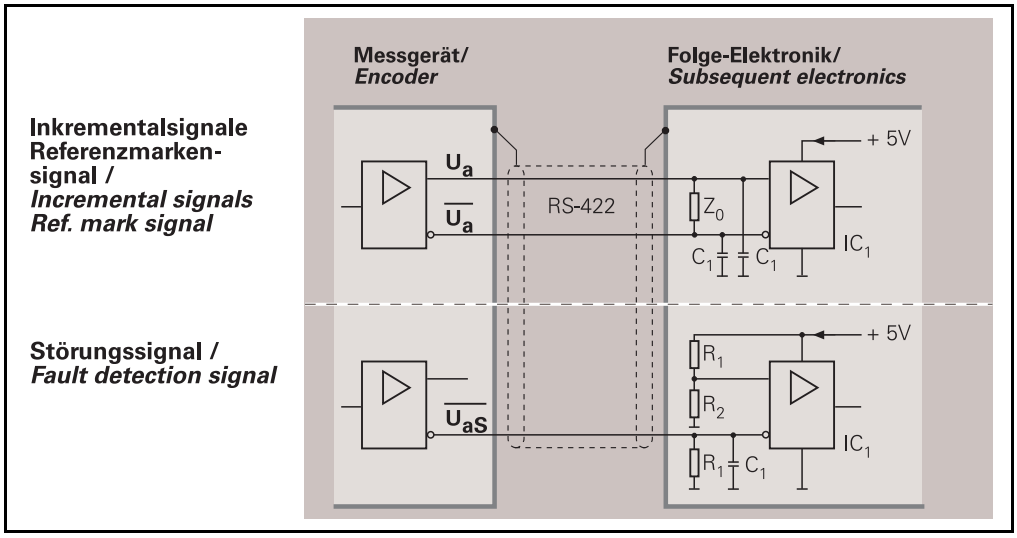
Störungssignal/
Fault detection signal



Recommended input circuit of subsequent electronics ⊓⊔ **TTL**

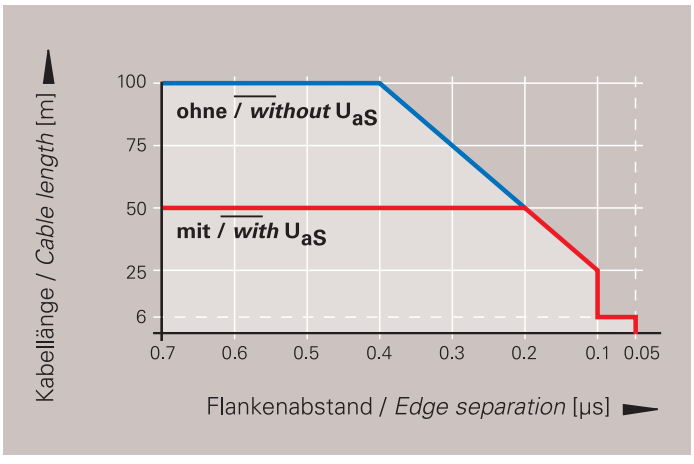
Dimensioning

Recommended differential line receivers	DS 26 C 32 AT AM 26 LS 32 (only if a > 0.1 µs)
	MC 3486
	SN 75 ALS 193
R_1	4.7 kΩ
R_2	1.8 kΩ
Z_0	120 Ω
C_1	220 pF



Cable lengths

The permissible **cable length** for transmission of the TTL square-wave signals to the subsequent electronics depends on the edge separation a. It is max. 100 m, or 50 m for the fault detection signal. The supply voltage at the encoder (see specifications) must be ensured. The sensor lines can be used to measure the voltage at the encoder and, if required, correct it with an automatic control system (remote sense power supply).



Zulässige Kabellänge in Abhängigkeit vom Flankenabstand /
Permissible cable length with respect to the edge separation

Possible specifications

e.g. Encoder	Meas. step[1] Interpolation[2]	Traversing speed	Edge separation a	Scanning frequency[2]	Ref. pulse delay time	Fault detection signal
LS 176 **LS 476** **LS 477**	1 µm / 5-fold	120 m/min[3] 120 m/min 60 m/min	≥ 0.25 µs ≥ 0.5 µs ≥ 1 µs	200 kHz 100 kHz 50 kHz	$\|t_d\| \leq 50$ ns	yes
	0.5 µm / 10-fold	120 m/min 60 m/min 30 m/min		100 kHz 50 kHz 25 kHz		
LS 623 **LS 629**	0.5 µm / none	60 m/min	≥ 2.5 µs	100 kHz		yes
LS 323	0.5 µm / none	120 m/min	≥ 1.25 µs	100 kHz	Ref. pulse non-gated	no
LIM 571	10 µm / 256-fold	600 m/min	≥ 0.5 µs	1 kHz	$\|t_d\| \leq 0.1$ µs	yes

[1] After 4-fold evaluation
[2] Please indicate when ordering
[3] Mechanical limit

8.2.2 Incremental signals ⊓⊔ HTL with square-wave interface

Rotary encoders that output HTL square-wave signals feature electronics digitizing the sinusoidal scanning signals. Available output signals are two **square-wave pulses Ua1 and Ua2**, phase-shifted by 90° elec. as well as the **reference pulse Ua0** gated with the incremental signals. A **fault detection signal $\overline{\text{UaS}}$** indicates fault conditions such as an interruption of supply lines, failure of the light source, etc. The integrated electronics also generate the **inverse signals** of all square-wave pulse trains (not on ERN/ROD 1x30).

The **measuring step** results from the spacing between two edges of the signals Ua1 and Ua2 by 1-fold, 2-fold or 4-fold evaluation.

The subsequent electronics must be designed such that it captures every edge of the square-wave pulses. The minimum **edge separation a** stated in the specifications refers to a measurement at the output of the given differential input circuit. To avoid counting errors the subsequent electronics should be designed such that it can operate with 90% of the edge separation a.
The max. permissible **shaft speed** or **traversing velocity** must never be exceeded.

Examples of encoders

ERN 130, ERN 430, ERN 1030, ROD 43x, ROD 1030

Incremental signals

Two HTL square-wave signals Ua1 and Ua2 and their inverted signals $\overline{\text{Ua1}}$ and $\overline{\text{Ua2}}$ (ERN/ROD 1x30 without $\overline{\text{Ua1}}$ and $\overline{\text{Ua2}}$)

Edge separation	a ≥ 0.45 µs at 300 kHz scanning frequency
	a ≥ 0.8 µs at 160 kHz scanning frequency
	a ≥ 1.3 µs at 100 kHz scanning frequency

Reference mark signal

One square-wave pulse Ua0 and its inverted pulse $\overline{Ua0}$
(ERN/ROD 1x30 without $\overline{Ua0}$)

Pulse width	90° elec. (other widths available on request)
Delay time	$\lvert t_d \rvert \leq$ 50 ns with gated reference pulse

Fault-detection signal

1 square-wave pulse UaS	Interference = LOW Proper function = HIGH

Signal data

Signal levels with Up = 24 V, without cable	$U_H \geq$ 21 V with $-I_H$ = 20 mA $U_L \leq$ 2.8 V with I_L = 20 mA
Permissible load	$\lvert I_L \rvert \leq$ 100 mA (max. load per output, except $\overline{UaS}$)
Capacitive load	$C_{load} \leq$ 10 nF with respect to 0 V
Short-circuit stability	Outputs short-circuit proof max. 1 min. with respect to 0 V and Up (except $\overline{UaS}$)
Switching times (10 % to 90 %) with 1 m cable and recommended input circuit	Rise time $t_+ \leq$ 200 ns Fall time $t_- \leq$ 200 ns

Connecting cable

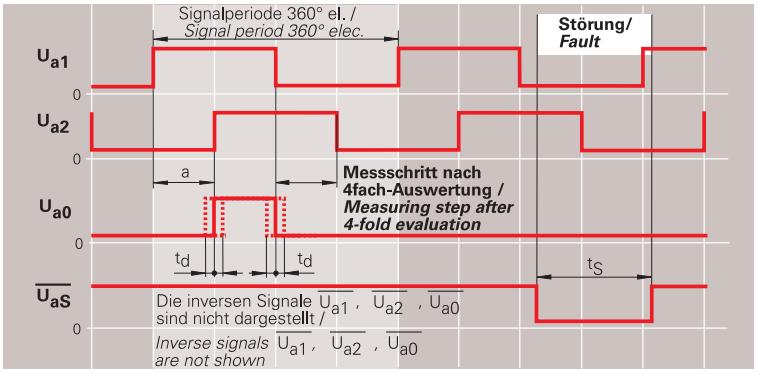
Shielded HEIDENHAIN cable	PUR [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	max. 300 m (ERN/ROD 1x30 max. 100 m)
Propagation time	6 ns/m

Inkrementalsignale/
Incremental signals

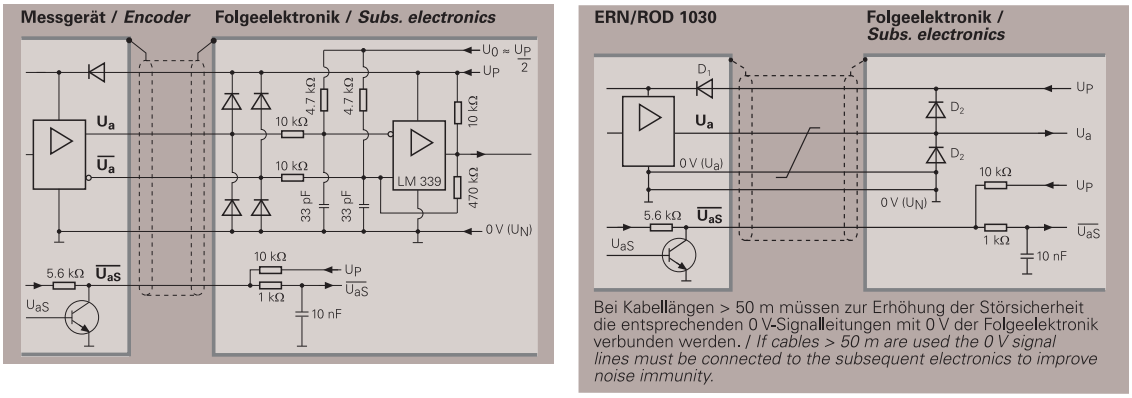
U_{a2} nacheilend zu U_{a1} bei Rechtsdrehung (auf Flansch gesehen)/
U_{a2} lagging U_{a1} with ccw rotation (view onto flange)

Referenzmarkensignal/
Ref. mark signal

Störungssignal/
Fault detection signal



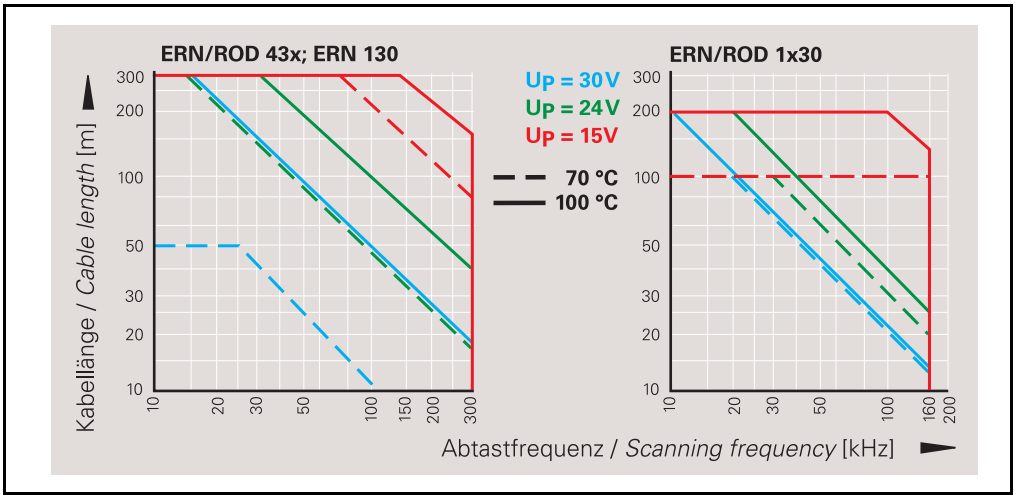
Recommended input circuit of subsequent electronics ⊓⊔ **HTL**


Messgerät / Encoder
Folgeelektronik / Subs. electronics
ERN/ROD 1030
Folgeelektronik / Subs. electronics
LM 339
0 V (UN)
0 V (Ua)
Bei Kabellängen > 50 m müssen zur Erhöhung der Störsicherheit die entsprechenden 0 V-Signalleitungen mit 0 V der Folgeelektronik verbunden werden. / If cables > 50 m are used the 0 V signal lines must be connected to the subsequent electronics to improve noise immunity.

Cable lengths

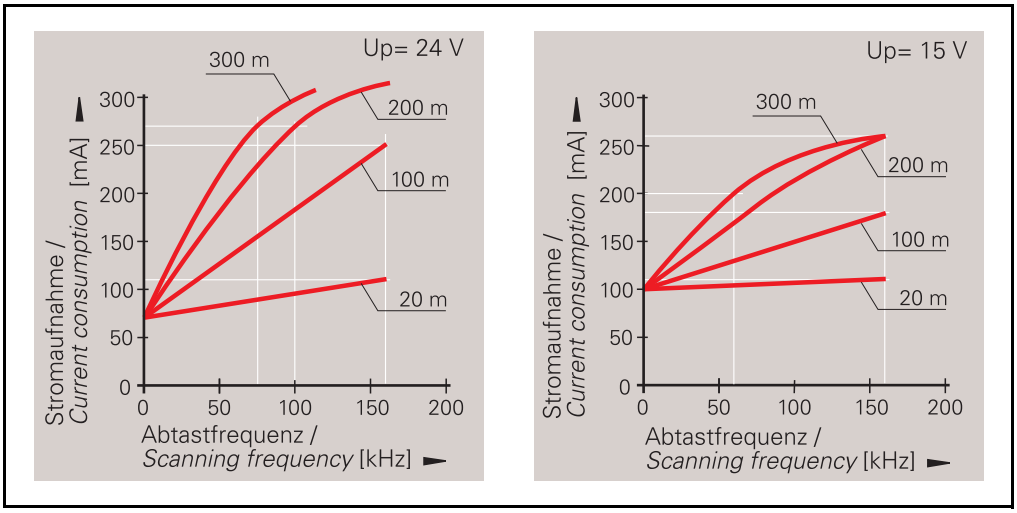
With incremental rotary encoders with HTL signals the maximum permissible cable length depends on the effective supply voltage and on the operating temperature of the encoder.

The limit on cable length ensures the correct switching times and edge steepness of output signals.



Current consumption

The current consumption of rotary encoders with HTL output signals depends on the output frequency and on the length of the cable to the subsequent electronics. The diagrams show typical curves for push-pull transmission with a 12-pin HEIDENHAIN cable. The maximum current consumption may be 50 mA higher.



8.3 Absolute Interfaces

8.3.1 Serial EnDat

Note

PWM 9 can be used to check the incremental signals;
see "Incremental signals1 Vpp" on page 117.
Via the BNC outputs the code signals can be transmitted to an oscilloscope (only possible in feed-through mode; system clock is required).
For checking and programming the EnDat interface an IK 215 / IK 115 expansion card is required.
The supply voltage of 5 V ± 5% (expanded: 3.6 V to 5.25 V or 14 V) at the absolute encoder has to be ensured!

The EnDat interface (**En**coder **Dat**a) of the absolute encoders is a **bidirectional** interface and therefore able to output **absolute position values** as well as to request and update information stored in the encoder. Thanks to **serial data transfer, four signal lines** are sufficient. The transfer mode (position values or parameters) is selected with MODE commands sent to the encoder by the subsequent electronics. The data are transferred **in synchronism** with the CLOCK signal prescribed by the subsequent electronics.

EnDat 2.2 and EnDat 2.1 versions

The extended interface version EnDat 2.2 is compatible with the version 2.1 as regards communication, command set (i.e. the available MODE commands) and time conditions , but it offers significant advantages. For example, it is possible to transfer additional information together with the position value without having to send a separate request. For this purpose the interface protocol was expanded and the time conditions (clock frequency, calculating time, recovery time) were optimized.
EnDat 2.1 and EnDat 2.2 are both available with or without incremental signals. The standard version of EnDat 2.2. units is without incremental signals, since these units feature a high internal resolution. To increase the resolution of EnDat 2.1 units, the incremental signals are evaluated in the subsequent electronics.

EnDat 2.2 (includes EnDat 2.1)

- Position values for incremental and absolute encoders
- Additional information on the position value
  - Diagnosis and test values
  - Absolute position values after referencing incremental encoders
  - Send and receive parameters
  - Commutation
  - Acceleration
  - Limit position signal
  - Temperature of encoder board
  - Temperature monitoring of an external temperature sensor (e.g. in motor coil)

EnDat 2.1

- Absolute position values
- Send and receive parameters
- Reset
- Test command and test values

Interface	Design	Clock frequency	Name on ID label	Power supply
EnDat 2.1	**With incremental signals**	≤ 2 MHz	EnDat 01	See specifications
	W/o incremental signals	≤ 2 MHz	EnDat 21	of the device
EnDat 2.2	With incremental signals	≤ 2 MHz	EnDat 02	Extended range
	W/o incremental signals	≤ 16 MHz	EnDat 22	3.6 to 5.25 V or 14 V

Bold: Standard version

Examples of encoders LC / ROC / ECN / ROQ / EQN/ECI/EQI ...

Interface EnDat (serial, bidirectional)

Data transfer Absolute position values, parameters and additional information

Data input	Differential line receiver as per EIA Standard RS 485 for signals CLOCK and $\overline{\text{CLOCK}}$ as well as DATA and $\overline{\text{DATA}}$
Data output	Differential line driver according to EIA standard RS 485 for the signals DATA and $\overline{\text{DATA}}$
Signal level	Differential voltage output > 1.7 V with 120 Ω load * (EIA standard RS 485) * Terminating resistor and receiver input resistor
Code	Pure binary code
LC traversing direction	Rising code values with traverse to the right (ID plate is on the left side!)
ROC direction of rotation	Rising code values with CCW rotation (view onto shaft)

Incremental signals ~ 1 Vpp device-dependent (see "Incremental signals1 Vpp" on page 117)

Connecting cable

Shielded HEIDENHAIN cable With incremental signals W/o incremental signals	PUR [(4 x 0.14 mm^2) + 2(4 x 0.14 mm^2) + (4 x 0.5 mm^2)] [(4 x 0.14 mm^2) + (4 x 0.34 mm^2)]
Cable length	Max. 150 m at 90 pF/m distributed capacitance
Propagation time	Max. 10 ns; typ. 6 ns/m

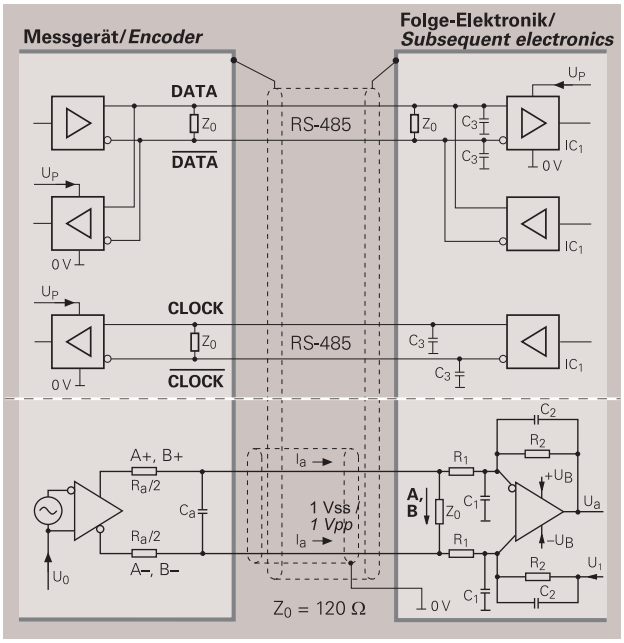
Recommended input circuit of the subsequent electronics EnDat interface

Code-Signale /
Code signals

IC_1 = RS 485-Differenz-leitungsempfänger /-treiber
Differential line receiver and driver
z.B./ *e.g.* SN 65 LBC 176 LT 485

C_3 = 330 pF
Z_0 = 120 Ω

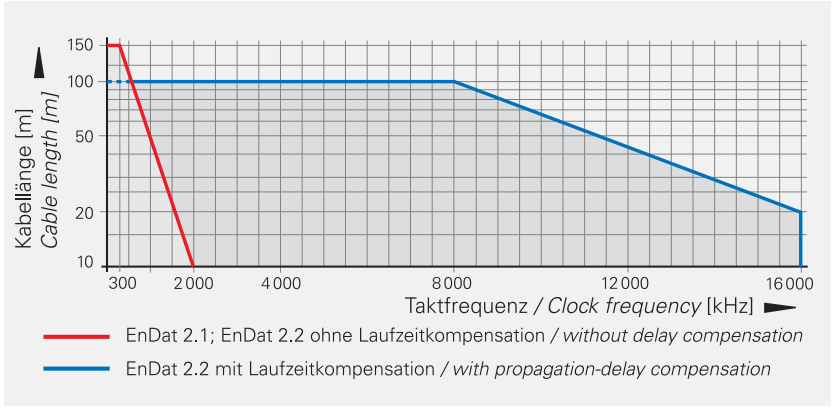
Incrementalsignale /
Incremental signals
geräteabhängig /
device-dependent



Dimensionierungsvorschlag siehe “Inkrementalsignale 1 Vss” /
Dimensioning proposal see “Incremental signals 1 Vpp”

Clock frequency / cable length

Without propagation-delay compensation the **clock frequency** is variable between **100 kHz and 2 MHz** depending on the cable length. Since large cable lengths and high clock frequencies increase the signal propagation time to the point that they can disturb unambiguous assignment of data, it can be measured in a test run and then compensated. With this **propagation-delay compensation** in the subsequent electronics, clock frequencies **up to 16 MHz** at cable lengths up to a maximum of 100 m ($f_{CLK} \leq$ 8 MHz) are possible. The maximum clock frequency is mainly determined by the cables and connecting elements used. To ensure proper function at clock frequencies above 2 MHz, use only original ready-made HEIDENHAIN cables.



Note

For further information on EnDat refer to the Internet at www.heidenhain.de!

Benefits of the EnDat interface

- **Automatic self-configuration:** All information required by the subsequent electronics is already stored in the encoder.
- **High system security** through alarms and messages for monitoring and diagnosis.
- **High transmission reliability** through cyclic redundancy checks.
- **Datum shift** for faster commissioning.

Other benefits of EnDat 2.2

- **A single interface** for all absolute and incremental encoders.
- **Additional information** (limit switches, temperature, acceleration)
- **Quality improvement:** Position value calculation in the encoder permits shorter sampling intervals (25 µs)
- **Online diagnostics** through valuation numbers that indicate the encoder's current functional reserves and make it easier to plan machine use.
- **Safety concept** for setting up safety-oriented control systems consisting of safe controls and safe encoders based on the standards DIN EN ISO 13 849-1 and IEC 61 508.

Advantages of purely serial transmission specifically for EnDat 2.2 encoders

- Cost optimization through **simple subsequent electronics** with EnDat receiver component and **simple connection technology**: Standard connecting element (M12; 8-pin), single-shielded standard cables and less complex wiring.
- **Minimized transmission times** through **high clock frequencies** up to 16 MHz. Position values are available in the subsequent electronics after approx. 10 µs.
- **Support for state-of-the-art machine designs**, e.g. direct drive technology.

Versions

The extended EnDat interface version 2.2 is compatible in its communication, command set and time conditions with version 2.1, but also offers significant advantages. It makes it possible, for example, to transfer additional information with the position value without sending a separate request for it. For this purpose the interface protocol was expanded and the time conditions (clock frequency, calculating time, recovery time) were optimized.

Ordering designation
Indicated on the ID label and can be read out via parameter.

Command set
The command set is the sum of all available MODE commands (see "Selection of transmission type"). The EnDat 2.2 command set includes the EnDat 2.1 MODE commands. When a MODE command from the EnDat 2.2 command set is transmitted to EnDat-01 subsequent electronics, the encoder or the subsequent electronics may generate an error message.

Incremental signals
EnDat 2.1 and EnDat 2.2 are both available with or without incremental signals. EnDat 2.2 encoders feature a high internal resolution. Therefore, depending on the control technology being used, interrogation of the incremental signals is not necessary. To increase the resolution of EnDat 2.1 encoders, the incremental signals are interpolated and evaluated in the subsequent electronics.

Power supply
Encoders with ordering designations EnDat 02 and EnDat 22 have an extended power supply range.

Functions

The EnDat interface transmits absolute position values or additional physical quantities (only EnDat 2.2) in an unambiguous time sequence and serves to read from and write to the encoder's internal memory. Some functions are available only with EnDat 2.2 MODE commands.

Position values can be transmitted with or without additional information. The additional information types are selectable via the Memory Range Select (MRS) code. Other functions such as parameter reading and writing can also be called after the memory area and address have been selected. Through simultaneous transmission with the position value, additional data can also be requested of axes in the feedback loop, and functions executed with them.

Parameter reading and writing is possible both as a separate function and in connection with the position value. Parameters can be read or written after the memory area and address are selected.

Reset functions serve to reset the encoder in case of malfunction. Reset is possible instead of or during position value transmission.

Servicing diagnosis makes it possible to inspect the position value even at standstill. A test command has the encoder send the required test values.

Selecting the transmission type

Transmitted data are identified as either position values, position values with additional information, or parameters. The type of information to be transmitted is selected by MODE commands. **MODE commands** define the content of the transmitted information. Every MODE command consists of three bits. To ensure reliable transmission, every bit is transmitted redundantly (inverted or double). The EnDat 2.2 interface can also transfer parameter values in the additional information together with the position value. This makes the current position values constantly available for the control loop, even during a parameter request.

Control cycles for transfer of position values
The transmission cycle begins with the first falling **clock edge**. The measured values are saved and the position value is calculated. After two clock pulses (2T), to **select the type of transmission**, the subsequent electronics transmit the MODE command "Encoder transmit position value" (with/without additional information).
The subsequent electronics continue to transmit clock pulses and observe the data line to detect the start bit. The **start bit** starts data transmission from the encoder to the subsequent electronics. Time tcal is the smallest time duration after which the position value can be read by the encoder. The subsequent **error messages,** error 1 and error 2 (only with EnDat 2.2 commands), are group signals for all monitored functions and serve as failure monitors.

Beginning with the LSB, the encoder then transmits the absolute **position value** as a complete data word. Its length varies depending on which encoder is being used. The number of required clock pulses for transmission of a position value is saved in the parameters of the encoder manufacturer. The data transmission of the position value is completed with the **Cyclic Redundancy Check** (CRC).
In EnDat 2.2, this is followed by additional information 1 and 2, each also concluded with a CRC. With the end of the data word, the clock must be set to HIGH. After 10 to 30 µs or 1.25 to 3.75 µs (with EnDat 2.2, the assignable recoveryt time tm) the data line falls back to low. Then a **new data transmission** can begin by starting the clock.

MODE commands

MODE commands	EnDat 2.1	EnDat 2.2
■ Encoder send position value ■ Selection of memory area ■ Encoder receive parameter ■ Encoder send parameter ■ Encoder receive reset[1)] ■ Encoder send test values ■ Encoder receive test command		
■ Encoder send position value with additional data ■ Encoder send position value and receive selection of memory area [2)] ■ Encoder send position value and receive parameter[2)] ■ Encoder send position value and send parameter[2)] ■ Encoder send position value and receive error reset[2)] ■ Encoder send position value and receive test command[2)] ■ Encoder receive communication command[3)]		

[1)] Same reaction as from switching the power supply off and on

[2)] Selected additional information is also transmitted

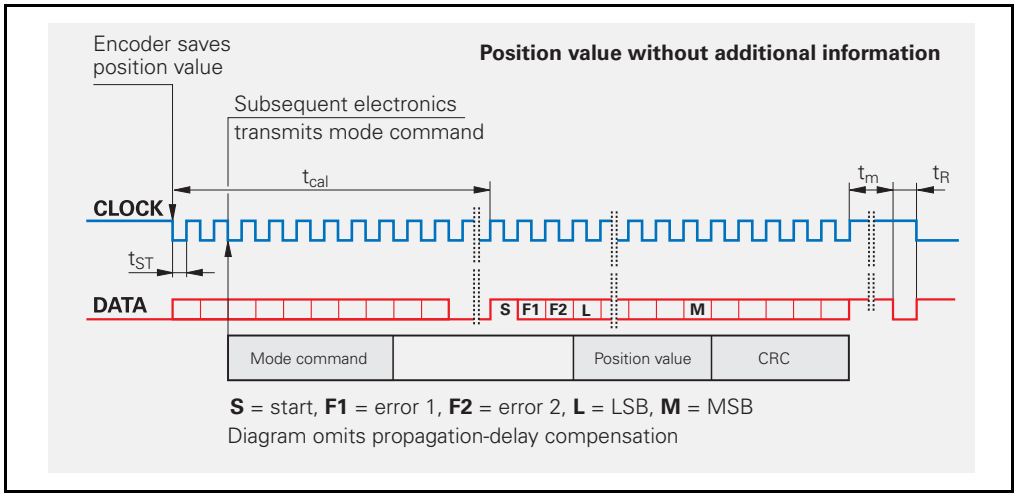
[3)] Reserved for encoders that do not support the safety system

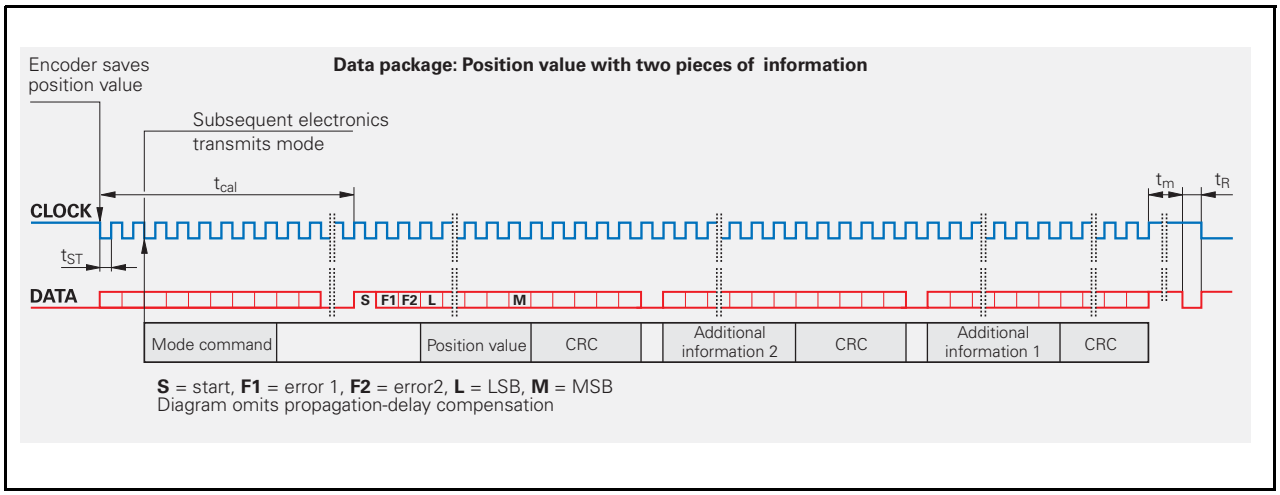
The time absolute linear encoders need for calculating the position values tcal differs depending on whether EnDat-2.1 or EnDat-2.2 MODE commands are transmitted (see catalog: Linear Encoders for Numerically Controlled Machine Tools – Specifications). If the incremental signals are evaluated for axis control, then the EnDat 2.1 MODE commands should be used. Only in this manner can an active error message be transmitted synchronously with the currently requested position value. EnDat 2.1 MODE commands should not be used for pure serial position-value transfer for axis control.

		Without delay compensation	With delay compensation
Clock frequency	f_c	100 kHz ... 2 MHz	100 kHz ... 16 MHz
Calculation time for Position value	t_{cal}	See Specifications	
Parameter	t_{ac}	Max. 12 ms	
Recovery time	t_m	EnDat 2.1: 10 to 30 µs EnDat 2.2: 10 to 30 µs or 1.25 to 3.75 µs (fc ≥ 1 MHz) (parameterizable)	
	t_R	Max. 500 ns	
	t_{ST}	-	2 µs to 10 µs
Data delay time	t_D	(0.2 + 0.01 x cable length in m) µs	
Pulse width	t_{HI}	0.2 to 10 µs	Pulse width fluctuation HIGH to LOW max. 10%
	t_{LO}	0.2 to 50 ms/30 µs (with LC)	

EnDat 2.2 transmission of position values

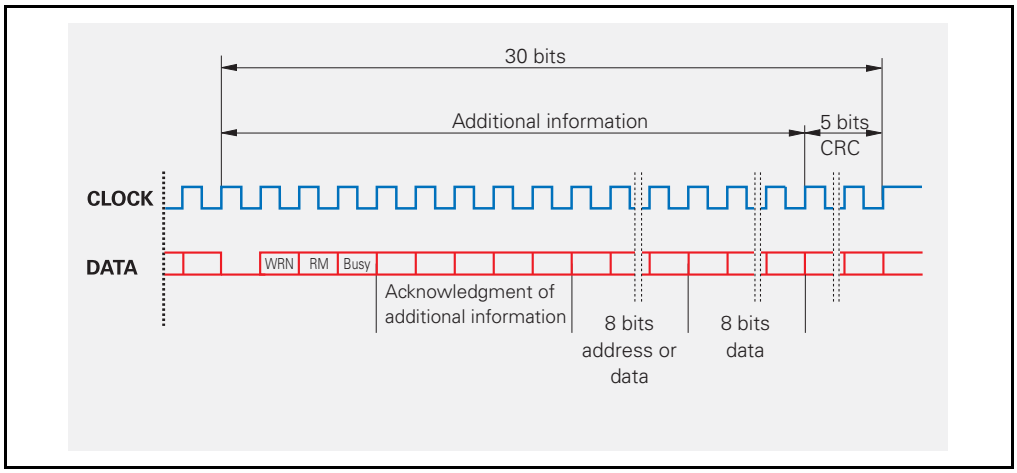
EnDat 2.2 can transmit position values with or without additional information.





Additional data

With EnDat 2.2, one or two pieces of additional information can be appended to the position value. Each additional information is 30 bits long with LOW as first bit, and ends with a CRC check. The additional information supported by the respective encoder is saved in the encoder parameters. The content of the additional information is determined by the MRS code and is transmitted in the next sampling cycle for additional information. This information is then transmitted with every sampling until a selection of a new memory area changes the content.



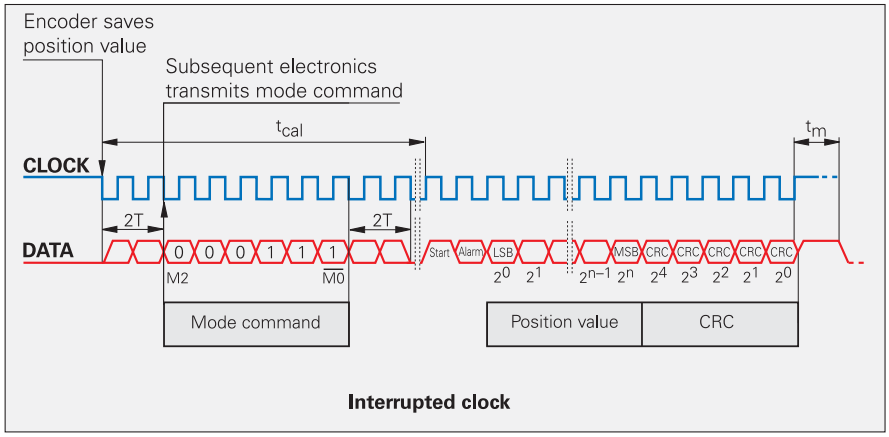
The additional information always begins with	The additional information can contain the following data	
Status data Warning – WRN Reference mark – RM Parameter request – Busy **Acknowledgment** of additional information	**Additional datum 1** Diagnosis (valuation numbers) Position value 2 Memory parameters MRS-code acknowledgment Test values Encoder temperature External temperature sensors Sensor data	**Additional datum 2** Commutation Acceleration Limit position signals Operating state error sources

EnDat 2.1 transmission of position values

EnDat 2.1 can transmit position values with interrupted clock pulse (as in EnDat 2.2) or continuous clock pulse.

Interrupted clock

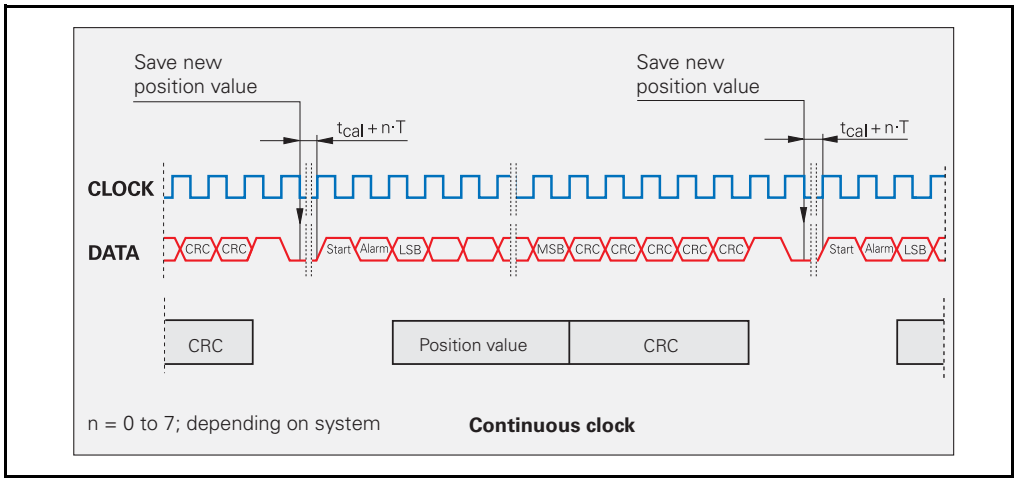
The interrupted clock is intended particularly for time-clocked systems such as closed control loops. At the end of the data word, the clock signal is set to HIGH level. After 10 to 30 µs (tm), the data line falls back to LOW. Then a new data transmission can begin by starting the clock.



Interrupted clock

Continuous clock

For applications that require fast acquisition of the measured value, the EnDat interface can have the clock run continuously. Immediately after the last CRC bit has been sent, the DATA line is switched to HIGH for one clock cycle, and then to LOW. The new position value is saved with the very next falling edge of the clock and is output in synchronism with the clock signal immediately after the start bit and alarm bit. Because the MODE command "Encoder transmit position value" is needed only once before the first data transmission, the continuous-clock transfer mode reduces the length of the clock-pulse group by10 periods per position value.

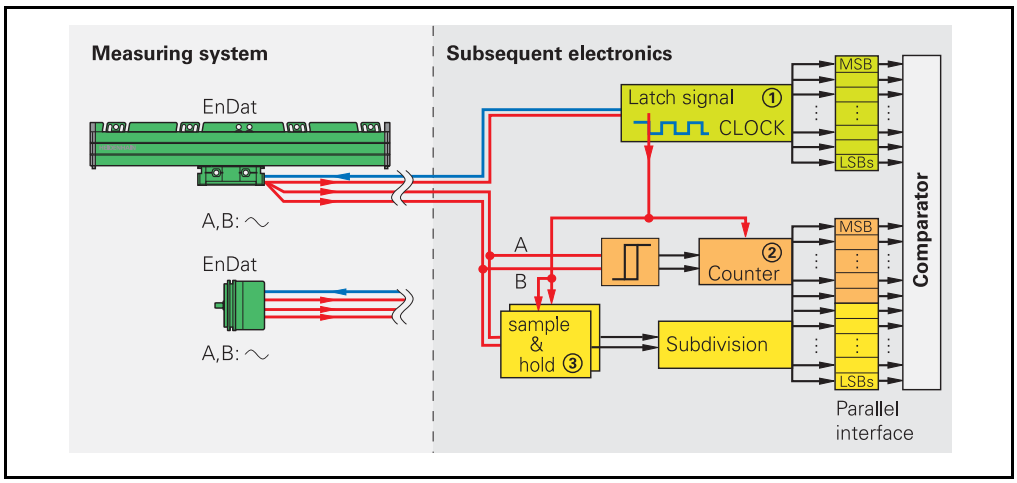


Synchronization of the serially transmitted code value with the incremental signal

Absolute encoders with EnDat interface can exactly synchronize serially transmitted absolute position values with incremental values. With the first falling edge (latch signal[1)]) of the CLOCK signal from the subsequent electronics, the scanning signals of the individual tracks in the encoder and counter[2)] are frozen, as are the A/D converters for subdividing the sinusoidal incremental signals in the subsequent electronics.

The code value transmitted over the serial interface unambiguously identifies one incremental signal period. The position value is absolute within one sinusoidal period of the incremental signal. The subdivided incremental signal can therefore be appended in the subsequent electronics to the serially transmitted code value.

After power on and initial transmission of position values, two redundant position values are available in the subsequent electronics. Since encoders with EnDat interface guarantee a precise synchronization—regardless of cable length—of the serially transmitted absolute value with the incremental signals, the two values can be compared in the subsequent electronics. This monitoring is possible even at high shaft speeds thanks to the EnDat interface's short transmission times of less than 50 µs. This capability is a prerequisite for modern machine design and safety systems.



Parameters and memory areas

The encoder provides several memory areas for parameters. These can be read from by the subsequent electronics, and some can be written to by the encoder manufacturer, the OEM, or even the end user. Certain memory areas can be write-protected.

Note

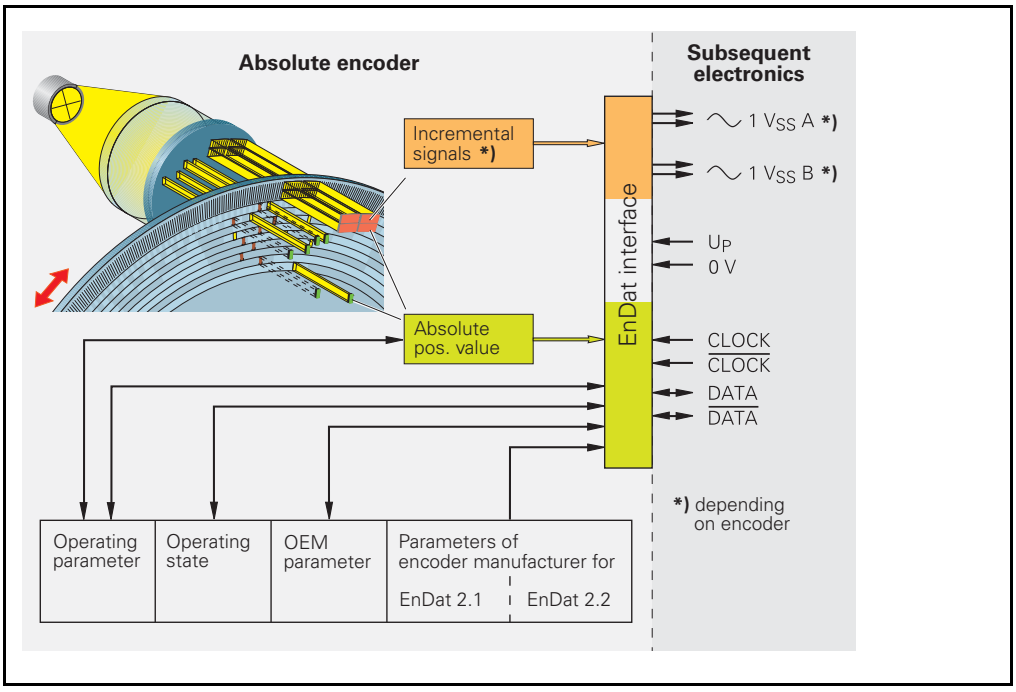
The parameters, which in most cases are set by the OEM, largely define the function of the encoder and the EnDat interface. When the encoder is exchanged, it is therefore essential that its parameter settings are correct. Attempts to configure machines without including OEM data can result in malfunctions. If there is any doubt as to the correct parameter settings, the OEM should be consulted.

Parameters of the encoder manufacturer
This write-protected memory area contains all **information specific to the encoder,** such as encoder type (linear/angular, singleturn/multiturn, etc.), signal periods, position values per revolution, transmission format of position values, direction of rotation, maximum speed, accuracy dependent on shaft speeds, warnings and alarms, ID number and serial number. This information forms the basis for **automatic configuration**. A separate memory area contains the parameters typical for EnDat 2.2, such as status of additional data, temperature, acceleration, support of diagnostic and error messages.

Parameters of the OEM
In this freely definable memory area, the OEM can store his information, e.g. the "electronic ID label" of the motor in which the encoder is integrated, indicating the motor model, maximum current rating, etc.

Operating parameters
This area is available for a **datum shift**, the configuration of diagnostics and for instructions. It can be protected against overwriting.

Operating status
This memory area provides detailed alarms or warnings for diagnostic purposes. Here it is also possible to activate write protection for the OEM parameter and operating parameter memory areas, and to interrogate their status. Once activated, **the write protection** can be reversed only by HEIDENHAIN service personnel.



Monitoring and diagnostic functions

The EnDat interface enables comprehensive monitoring of the encoder without requiring an additional transmission line. The alarms and warnings supported by the respective encoder are saved in the "parameters of the encoder manufacturer" memory area.

Error message
An error message becomes active if a **malfunction of the encoder** might result in incorrect position values. The exact cause of the disturbance is saved in the encoder's "operating status" memory. It is also possible to interrogate over the additional information "operating status error sources." For this purpose the EnDat interface transmits the error 1 and error 2 error bits (only with EnDat 2.2 commands). These are group signals for all monitored functions and serve for failure monitoring. The two error messages are generated independently from each other.

Warning
This collective bit is transmitted in the status data of the additional information. It indicates that certain **tolerance limits of the encoder** have been reached or exceeded—such as shaft speed or the limit of light source intensity compensation through voltage regulation—without implying that the measured position values are incorrect. This function makes it possible to issue preventive warnings in order to minimize idle time.

Online diagnostics
Encoders with purely serial interfaces do not provide incremental signals for evaluation of encoder function. EnDat 2.2 encoders can therefore cyclically transmit so-called valuation numbers from the encoder. The valuation numbers provide the current state of the encoder and ascertain the encoder's "functional reserves." The identical scale for all HEIDENHAIN encoders allows uniform valuation. This makes it easier to plan machine use and servicing.

Cyclic Redundancy Check
To ensure **reliability of data transfer,** a cyclic redundancy check (CRC) is performed through the logical processing of the individual bit values of a data word. This 5-bit long CRC concludes every transmission. The CRC is decoded in the receiver electronics and compared with the data word. This largely eliminates errors caused by disturbances during data transfer.

8.3.2 Synchronuos serial SSI

Note

PWM 9 can be used to check the incremental signals; see "Incremental signals1 Vpp" on page 117.

Via the BNC outputs the code signals can be transmitted to an oscilloscope (only possible in feed-through mode; system clock is required).

For checking and programming the EnDat interface an IK 115 expansion card is required. The supply voltage of 5 V ± 5% at the encoder has to be ensured!

Examples of encoders

ROC 410, ROC 412, ROC 413, ROQ 424, ROQ 425,
ECN 113, ECN 413, EQN 425

Interface

Serial SSI
The absolute position value, beginning with the Most Significant Bit (MSB first), is transferred in synchronism with a CLOCK signal transmitted by the control.
The SSI standard data word length for singleturn absolute encoders is 13 bits, and for multiturn absolute encoders 25 bits.

Code signals

Data input	Differential line receiver as per EIA Standard RS 485 for CLOCK and $\overline{\text{CLOCK}}$ signals
Data output	Differential line driver according to EIA standard RS 485 for DATA and $\overline{\text{DATA}}$ signals
Signal levels	Differential voltage output > 1.7 V with 120 Ω load * (EIA standard RS 485) * Terminating resistor and receiver input resistor
Code	Gray code
Direction of rotation	Code values increase with clockwise rotation (viewed from flange side)

Incremental signals ~ 1 Vpp (see "Incremental signals1 Vpp" on page 117)

In addition to the serial data transfer the listed absolute encoders output sinusoidal incremental signals with signal levels of 1 Vpp.

Connecting cable

Shielded HEIDENHAIN cable	PUR [(4 x 0.14 mm²) + 2(4 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	Max. 150 m at 90 pF/m distributed capacitance
Propagation time	6 ns/m

Recommended input circuit of the subsequent electronics SSI interface

Dimensioning IC_1 = differential line receiver and driver, e.g. SN 65 LBC 176 LT 485
Z_0 = 120 Ω

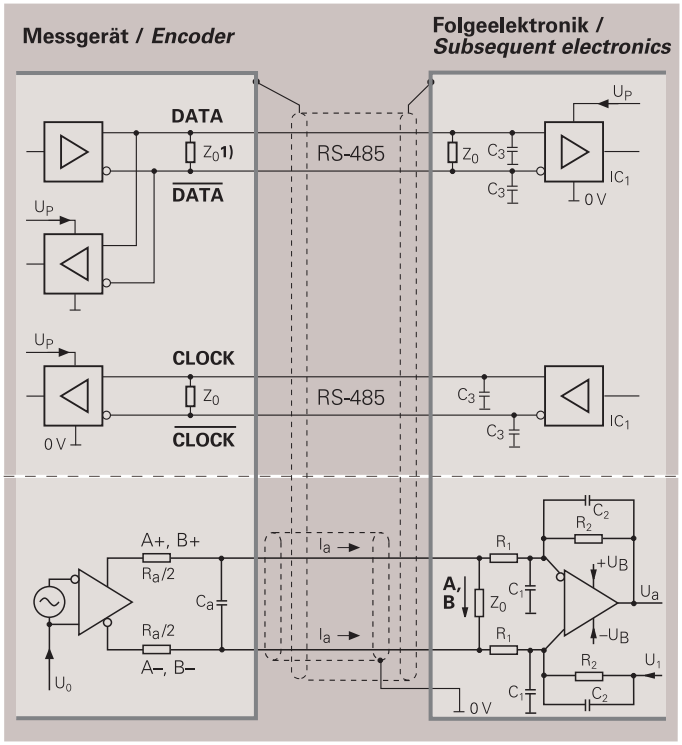
Code-Signale /
Code signals

Z_0 = 120 Ω

R_3 = 100 Ω[2)]
R_4 = 1 kΩ[2)]
C_3 = 330 pF (zur Verbesserung der Störfestigkeit) /
(serves to improve noise immunity)

Inkrementalsignale /
Incremental signals

[1)] bei Spannungsversorgung 10 bis 30 V nicht vorhanden /
not available with 10 to 30 V supply voltage
[2)] geräteabhängig /
depending on device



Cable lengths and permissible clock frequencies

Cable length	Clock pulse period	Clock frequency
50 m	1 to 10 µs	1000 kHz to 100 kHz
100 m	3.3 to 10 µs	approx. 300 kHz to 100 kHz

8.3.3 Synchronous serial SSI programmable

Note

PWM 9 can be used to check the incremental signals; see "Incremental signals1 Vpp" on page 117.
Via the BNC outputs the code signals can be transmitted to an oscilloscope (only possible in feed-through mode; system clock is required).
For checking and programming the EnDat interface an IK 115 expansion card is required.

The **absolute position value,** beginning with the most significant bit, is transferred over the data lines (DATA) in synchronism with a CLOCK signal from the control. A number of parameters and functions can be programmed with the enclosed programming software.

In addition to the absolute position values the sinusoidal **incremental signals** with 1 Vpp level are output (Signal description see "Synchronuos serial SSI" on page 138).

The **fault-detection signal** reports errors, such as breaks in the power line, failure of the light source etc.

Programmable functions and parameters

The encoders are programmed with HEIDENHAIN software on a personal computer. The software can also be used to check the parameter settings. Some functions that have no influence on the interface configuration can also be activated by hardware via the connector.

Interface

- Output format of the position values: Gray code or dual code
- Direction of rotation for increasing position values (also configurable by jumpers)
- Data format synchronous-serial right-aligned or 25-bit fir tree format (SSI)

Position values

- Singleturn resolution up to 8192 absolute positions per revolution, e.g. for adaptation to various screw pitches.
- Multiturn resolution up to 4096 distinguishable revolutions, e.g. for adaptation to the ball-screw length.

Setting the scaling

- Factor for reducing the singleturn resolution
- Unit-distance integral reduction of singleturn or multiturn positions

Offset/preset

- Offset and preset values for zeroing and compensation
- Setting the preset value defined by software through the connector

For further information refer to http://www.heidenhain.de on the Internet.

Examples of encoders

ROQ 425 programmable

Code signals

Interfaces	Serial in the SSI (fir tree) or synchronous-serial right-aligned (programmable) data formats
Data input	Differential line receiver as per EIA Standard RS 485 for signals CLOCK and $\overline{\text{CLOCK}}$ as well as DATA and $\overline{\text{DATA}}$
Data output	Differential line driver according to EIA standard RS 485 for DATA and $\overline{\text{DATA}}$ signals
Signal levels	Differential voltage output > 2 V (EIA standard RS 485)
Code	Gray code or dual code (programmable)
Direction of rotation	Code values increase with clockwise or counterclockwise rotation, viewed from flange side (programmable)

Incremental signals ~ 1 Vpp (see "Incremental signals1 Vpp" on page 117)

Fault detection signal UaS

1 square-wave pulse $\overline{\text{UaS}}$ (HTL)	Interference = LOW Proper function = HIGH

Programming inputs

	Direction of rotation and reset
Inactive	LOW < 0.25 x Up or input open
Active	HIGH > 0.6 x Up
Switching time	t_{min} > 1 ms

Connecting cable

Shielded HEIDENHAIN cable	PUR [(4 x 0.14 mm^2) + 2(4 x 0.14 mm^2) + (4 x 0.5 mm^2)]
Cable length	Max. 150 m at 90 pF/m distributed capacitance
Propagation time	6 ns/m

Recommended input circuit of subsequent electronics

Code-Signale / *Code Signals*

IC_1 =
RS-485 Differenzleitungs-empfänger und -treiber /
Differential line receiver and driver
Z_0 = 120 Ω
C_3 = 330 pF (zur Verbesserung der Störfestigkeit) /
(serves to improve noise immunity)

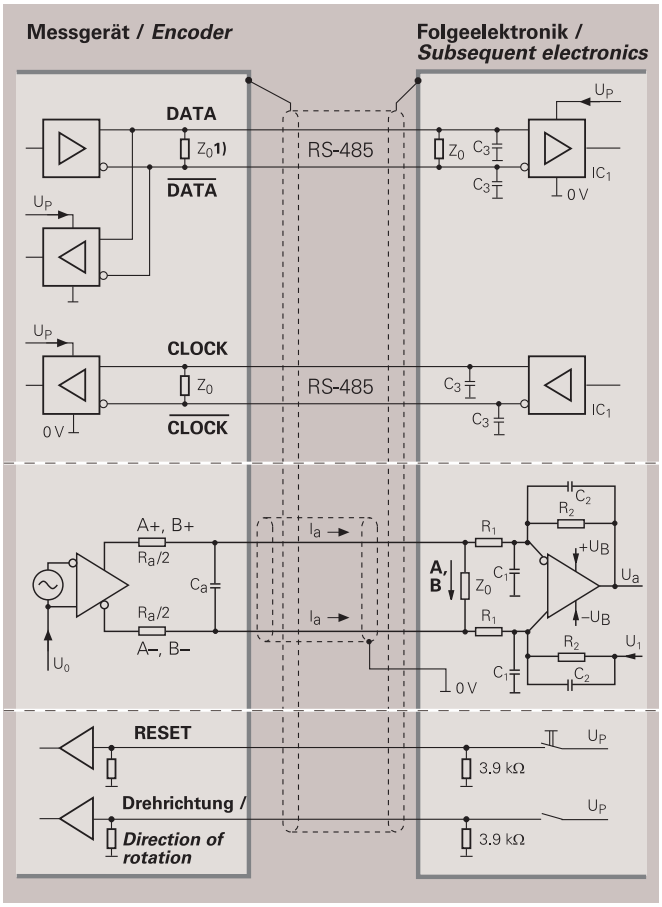
Inkrementalsignale / *Incremental signals*

[1] bei Spannungsversorgung 10 bis 30 V nicht vorhanden / *not available with 10 to 30 V supply voltage*

Störungssignal / *Fault detection signal*

Programmier-Schnittstelle / *Programming interface*

Programmierung über Steckverbinder / *Programming via connectors*

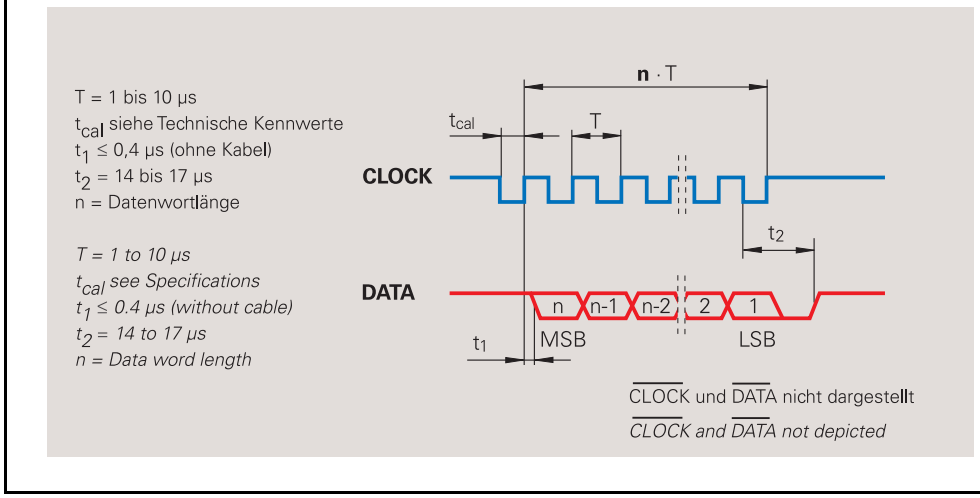


Control cycle for complete data word

In the quiescent state clock and data lines are at high-level. With the first falling edge of the clock the current measured value is saved. Data transfer begins with the first rising clock edge.

When a complete data word was transferred the data output remains at low level, until the encoder is ready for a new measured value latch (t2). If another data-output request (CLOCK) is received within this time, the same data will be output once again.

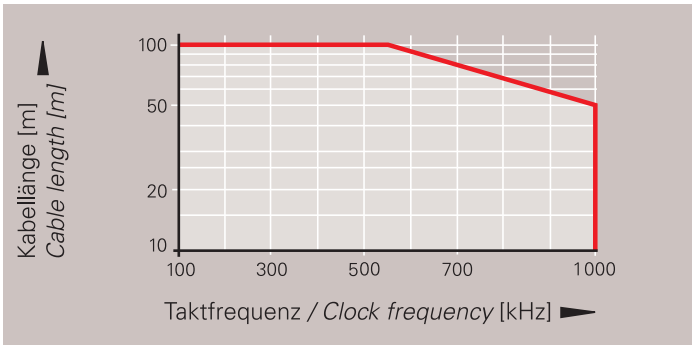
If data output is interrupted (CLOCK = high for t ≥ t2) a new measured value is saved with the next falling edge. With the next rising clock edge the subsequent electronics adopts the data.



Data word length n

ROC 413 ECN 113 ECN 413	ROC 412	ROC 410	ROQ 424	ROQ 425 EQN 425
13 bits	13 bits	13 bits	25 bits	25 bits

Permissible clock frequency with respect to cable lengths

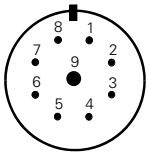


9 Pin Layouts

9.1 Interface PCBs

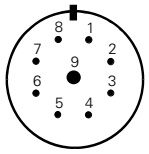
11 µApp

9-polige HEIDENHAIN-Flanschdose
an Interfaceplatine Flanschdose: IN
9-pin HEIDENHAIN flange socket
at IN flange socket of interface board



1	2	5	6	7	8	3	4	9
I_1		I_2		I_0		5 V	0 V	0 V
+	–	+	–	+	–	U_P	U_N	Innenschirm *Internal shield*

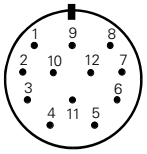
9-polige HEIDENHAIN-Flanschdose
an Interfaceplatine Flanschdose: OUT
9-pin HEIDENHAIN flange socket
at OUT flange socket of interface board



1	2	5	6	7	8	3	4	9
I_1		I_2		I_0		5 V	0 V	frei *free*
+	–	+	–	+	–	U_P	U_N	

1 Vpp

12-polige HEIDENHAIN-Flanschdose
an Interfaceplatine Flanschdose: IN
an Interfaceplatine Flanschdose: OUT
12-pin HEIDENHAIN flange socket
at IN flange socket of the interface board
at OUT flange socket of the interface board

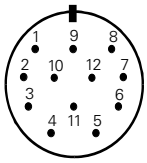


5	6	8	1	3	4	12	10	2	11	9	7
A		B		R		5 V	0 V	5 V	0 V	frei *free*	frei *free*
+	–	+	–	+	–	Up	U_N	Sensor	Sensor		

Except for the PWM 9 MODE: MEASURE U/I the sensor lines are connected to the encoder supply lines.

TTL

12-polige HEIDENHAIN-Flanschdose
an Interfaceplatine Flanschdose: IN
an Interfaceplatine Flanschdose: OUT
12-pin HEIDENHAIN flange socket
at IN flange socket of the interface board
at OUT flange socket of the interface board

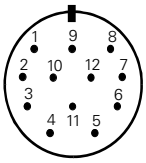


1	2	3	4	5	6	7	8	9	10	11	12
$\overline{Ua2}$	+5 V Sensor	Ua0	$\overline{Ua0}$	Ua1	$\overline{Ua1}$	$\overline{UaS}$	Ua2	Gehäuse *Chassis*	0 V U_N	0 V Sensor	+5 V U_P

Except for the PWM 9 MODE: MEASURE U/I the sensor lines are connected to the encoder supply lines.

HTL

12-polige HEIDENHAIN-Flanschdose
an Interfaceplatine Flanschdose: IN
an Interfaceplatine Flanschdose: OUT
12-pin HEIDENHAIN flange socket
at IN flange socket of the interface board
at OUT flange socket of the interface board

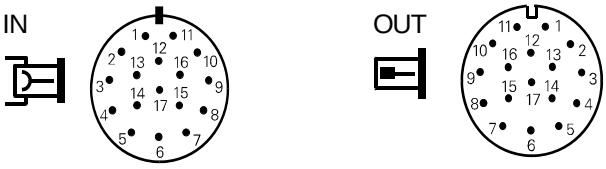


1	2	3	4	5	6	7	8	9	10	11	12
$\overline{Ua2}$	10-30 V Sensor	Ua0	$\overline{Ua0}$	Ua1	$\overline{Ua1}$	$\overline{UaS}$	Ua2	Gehäuse *Chassis*	0 V U_N	0 V Sensor	10-30 V U_P

Except for the PWM 9 MODE: MEASURE U/I the sensor lines are connected to the encoder supply lines.

Absolute/1 Vpp

17-pol. HEIDENHAIN-Flanschdose
an Interfaceplatine Stecker: IN
an Interfaceplatine Flanschdose: OUT
17-pin HEIDENHAIN flange socket
Interface board connector: IN
Interface board flange socket: OUT



Note

The PIN layout of this interface board depends on the encoder connected and on the soft-key settings.
See "EnDat 2.1" on page 147, "SSI Serial Interface" on page 148, "Serial Interface SSI Programmable" on page 148, "Drive Encoders and Absolute Encoders" on page 154.

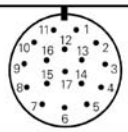
9.2 Power Supply Connector (Female)

8-polige Stromversorgungs-Buchse DC-IN
8-pin power supply socket DC-IN

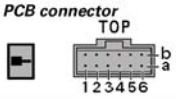
1	2	3	4	5	6	7	8
10-30V				0V			

9.3 EnDat 2.1

17-pol. HEIDENHAIN-Kupplung oder -Flanschdose
17-pin HEIDENHAIN coupling or flange socket



12-pol. Platinenstecker
12-pin PCB connector



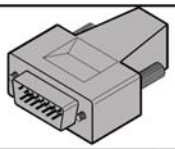
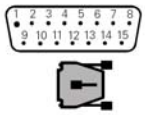
	Spannungsversorgung *Power supply*					Inkrementalsignale *Incremental signals*				absolute Positionswerte *Absolute position values*			
	7	**1**	**10**	**4**	**11**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**
	1b	**6a**	**4b**	**3a**	**/**	**2a**	**5b**	**4a**	**3b**	**6b**	**1a**	**2b**	**5a**
	Up	**Sensor** Up [1]	**0 V**	**Sensor** 0 V [1]	**Innen-schirm** ***Inside shield***	**A+**	**A–**	**B+**	**B–**	**DATA+**	**DATA–**	**CLOCK**	**CLOCK–**
	braun/grün *brown/green*	blau *blue*	weiß/grün *white/green*	weiß *white*	/	grün/schwarz *green/black*	gelb/schwarz *yellow/black*	blau/schwarz *blue/black*	rot/schwarz *red/black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*

	sonstige Signale *other signals*	
	5	**6**
	–	–
	T+ [2]	**T–** [2]
	braun [2] *brown*	weiß [2] *white*

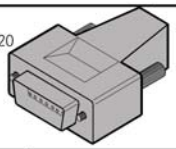
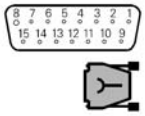
External shield lies on housing.
Up = Supply voltage
T = Temperature
Sensor: The sensor line is internally connected to the power supply line.
Vacant pins or wires must not be used!

[1] Not assigned if a power of 7 to 10 V is supplied via adapter inside the motor housing
[2] Only for motor-internal adapter cables

15-pol. Sub-D-Stecker, Stift
für IK 115
15-pin D-sub connector, male
for IK 115

15-pol. Sub-D-Stecker, Buchse
für HEIDENHAIN-Steuerungen und IK 220
15-pin D-sub connector, female,
for HEIDENHAIN controls and IK 220

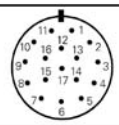



	Spannungsversorgung *Power supply*					Inkrementalsignale *Incremental signals*				absolute Positionswerte *Absolute position values*			
	4	**12**	**2**	**10**	**6**	**1**	**9**	**3**	**11**	**5**	**13**	**8**	**15**
	1	**9**	**2**	**11**	**13**	**3**	**4**	**6**	**7**	**5**	**8**	**14**	**15**
	Up	**Sensor** Up	**0 V**	**Sensor** 0 V	**Innen-schirm** ***Internal shield***	**A+**	**A–**	**B+**	**B–**	**DATA+**	**DATA–**	**CLOCK+**	**CLOCK–**
	braun/grün *brown/green*	blau *blue*	weiß/grün *white/green*	weiß *white*	/	grün/schwarz *green/black*	gelb/schwarz *yellow/black*	blau/schwarz *blue/black*	rot/schwarz *red/black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*

External shield lies on housing.
Up = Supply voltage
Sensor: The sensor line is internally connected to the power supply line.
Vacant pins or wires must not be used!

9.4 SSI Serial Interface

17-pol. HEIDENHAIN-Kupplung
17-pin HEIDENHAIN coupling

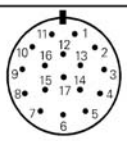


	Spannungsversorgung EN 50178 *Power supply EN 50178*					Inkrementalsignale *Incremental signals*				absolute Positionswerte *Absolute position values*			
	7	**1**	**10**	**4**	**11**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**
	Up	**Sensor** Up	**U_N** 0 V	**Sensor** 0 V	**Innen-schirm** ***Internal shield***	**A+**	**A–**	**B+**	**B–**	**DATA+**	**DATA–**	**CLOCK+**	**CLOCK–**
	braun/grün *brown/green*	blau *blue*	weiß/grün *white/green*	weiß *white*	/	grün/schwarz *green/black*	gelb/schwarz *yellow/black*	blau/schwarz *blue/black*	rot/schwarz *red/black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*

External shield lies on housing.
Up = Supply voltage
Sensor: The sensor line is internally connected to the power supply line.
Vacant pins or wires must not be used!

9.5 Serial Interface SSI Programmable

17-pol. HEIDENHAIN-Flanschdose
17-pin HEIDENHAIN flange socket



	Spannungsversorgung *Power supply* EN 50178			Inkrementalsignale *Incremental signals*				absolute Positionswerte *Absolute position values*			
	7	**10**	**11**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**
	Up 10 - 30 V	**U_N** 0 V	**Innen-schirm** ***Internal shield***	**A+**	**A–**	**B+**	**B–**	**DATA+**	**DATA–**	**CLOCK+**	**CLOCK–**
	braun/grün *brown/green*	weiß/grün *white/green*	/	grün/schwarz *green/black*	gelb/schwarz *yellow/black*	blau/schwarz *blue/black*	rot/schwarz *red/black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*

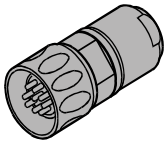
	sonstige Signale					
	1	**4**	**3**	**2**	**5**	**6**
	RxD	**TxD**	**$\overline{\text{UaS}}$**	**Drehrichtung** ***Rotational direction***	**Preset 1**	**Preset 2**
	blau *blue*	weiß *white*	rot *red*	schwarz *black*	grün *green*	braun *brown*

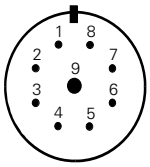
Shield on housing.
Up = Supply voltage

9.6 Standard HEIDENHAIN Cables

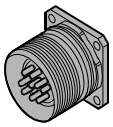
11 µApp

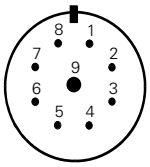
9-pol. HEIDENHAIN-Stecker
9-pin HEIDENHAIN connector





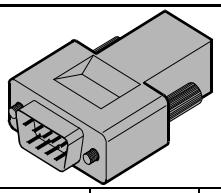
9-pol. Flanschdose
9-pin flange socket

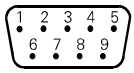




1	2	3	4	5	6	7	8	9	Gehäuse *Housing*
I_1	I_1	5V Up	0V U_N	I_2	I_2	I_0	I_0	Innenschirm *Internal shield*	Außenschirm *External shield*
+	–			+	–	+	–		
grün *green*	gelb *yellow*	braun *brown*	weiß *white*	blau *blue*	rot *red*	grau *grey*	rosa *pink*	weiß/braun white/brown	

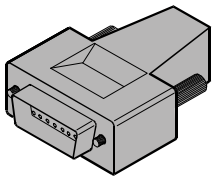
9-pol. Sub-D-Stecker
für HEIDENHAIN PC-Zählerkarte IK 121A
9-pin D-sub-connector
for HEIDENHAIN IK 121A counter card

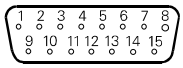




1	2	3	4	5	6	7	8	9	Gehäuse *Housing*
I_1	0V U_N	I_2	Innenschirm *Internal shield*	I_0	I_1	5V Up	I_2	I_0	Außenschirm *External shield*
–		–		–	+		+	+	
gelb *yellow*	weiß *white*	rot *red*	weiß/braun *white/brown*	rosa *pink*	grün *green*	braun *brown*	blau *blue*	grau *grey*	

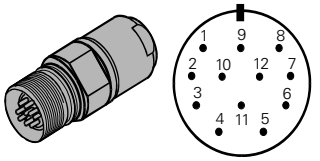
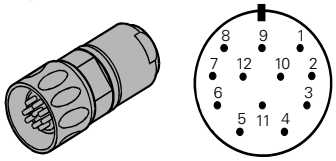
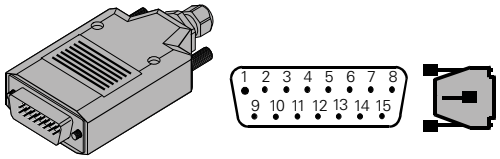
15-pol. Sub-D-Stecker
für HEIDENHAIN-Bahnsteuerung TNC 410, TNC 426, TNC 430
15-pin D-sub-connector
for HEIDENHAIN contouring control TNC 410, TNC 426, TNC 430





1	2	3	4	5, 8, 9, 11, 14, 15	6	7	10	12	13	Gehäuse *Housing*
5V Up	0V U_N	I_1	I_1		I_2	I_2	I_0	I_0	Innenschirm *Internal shield*	Außenschirm *External shield*
		+	–		+	–	+	–		
braun *brown*	weiß *white*	grün *green*	gelb *yellow*	frei *free*	blau *blue*	rot *red*	grau *grey*	rosa *pink*	weiß/braun *white/brown*	

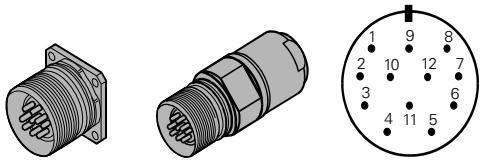
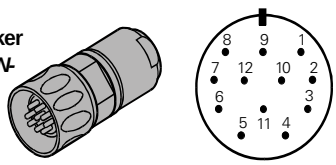
TTL

12-pol. HEIDENHAIN-Kupplung *12-pin HEIDENHAIN coupling*	**12-pol. HEIDENHAIN-Stecker** *12-pin HEIDENHAIN connector*	**15-pol. Sub-D-Stecker (Stift) an LIF 171** *15pin D-sub connector (male) on LIF 171*
		

	5	**6**	**8**	**1**	**3**	**4**	**12**	**10**	**2**	**11**	**9**	**7**	***/***	**Gehäuse** ***Housing***
	1	**9**	**3**	**11**	**14**	**7**	**4**	**2**	**12**	**10**	***/***	**13**	**15**	**Außen-schirm** ***External shield***
	Ua1	**—— Ua1**	**Ua2**	**—— Ua2**	**Ua0**	**—— Ua0**	**5V Up**	**0V U_N**	**5V Sensor**	**0V Sensor**	**frei** ***free***	**—— UaS**	1)	
	braun *brown*	grün *green*	grau *grey*	rosa *pink*	rot *red*	schwarz *black*	braun/ grün *brown/ green*	weiß/ grün *white/ green*	blau *blue*	weiß *white*	/	violett *violet*	gelb *yellow*	
							IEC742 EN 50178							

The sensor line is internally connected to the power supply line. External shield lies on housing.
1) TTL/11µApp switchover

1 Vpp

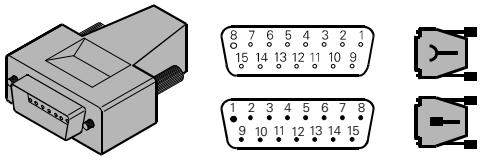
12-pol. HEIDENHAIN-Flanschdose oder -Kupplung *12-pin HEIDENHAIN-flange socket or coupling*	**12-pol. HEIDENHAIN-Stecker** *12-pin HEIDENHAIN-connector*
	

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	***/***	**Gehäuse** ***Housing***
B	**5V Sensor**	**R**	**R**	**A**	**A**	***/***	**B**	**frei** ***free***	**0V U_N**	**0V Sensor**	**5V Up**	**frei** ***free***	**Außen-schirm** ***External shield***
–		+	–	+	–		+						
rosa *pink*	blau *blue*	rot *red*	schwarz *black*	braun *brown*	grün *green*	violett *violet*	grau *grey*	/	weiß/ grün *white/ green*	weiß *white*	braun/ grün *brown/ green*	gelb *yellow*	

The sensor line is internally connected to the power supply line. External shield lies on housing.

1 Vpp

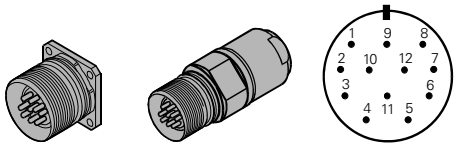
15-poliger Sub-D-Stecker (Buchse)
für HEIDENHAIN-Bahnsteuerung TNC 410, TNC 426, TNC 430
15-poliger Sub-D-Stecker (Stift)
für HEIDENHAIN-PC-Zählerkarte IK 121 V
15-pin D-sub connector (female)
for HEIDENHAIN contouring controls TNC 410, TNC 426, TNC 430
15-pin D-sub connector (male)
for HEIDENHAIN IK 121 V Counter Card for PCs



	3	**4**	**6**	**7**	**10**	**12**	**1**	**2**	**9**	**11**	**5/8/ 13/15**	**14**	**/**	**Gehäuse *Housing***
	1	**9**	**3**	**11**	**14**	**7**	**4**	**2**	**12**	**10**	**5/6/ 8/15**	**13**	**/**	**Außen-schirm *External shield***
	A		**B**		**R**		**5V Up**	**0V U_N**	**5V Sensor**	**0V Sensor**	**frei *free***	**frei / nicht belegen *free/do not use***	**frei *free***	
	+	–	+	–	+	–								
	braun *brown*	grün *green*	grau *grey*	rosa *pink*	rot *red*	schwarz *black*	braun/ grün *brown/ green*	weiß/ grün *white/ green*	blau *blue*	weiß *white*	/	violett *violet*	gelb *yellow*	

HTL

12-pol. HEIDENHAIN-
Flanschdose oder -Kupplung
12-pin HEIDENHAIN
flange socket or coupling

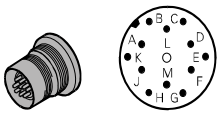


1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**/**	**Gehäuse *Housing***
$\overline{Ua2}$	**10 - 30 V** Sensor	**Ua0**	**$\overline{Ua0}$**	**Ua1**	**$\overline{Ua1}$**	**$\overline{UaS}$**	**Ua2**	**frei *free***	**0V** (U_N)	**0V** Sensor	**10 - 30 V** (Up)	**frei *free***	**Außen-schirm *External shield***
rosa *pink*	blau *blue*	rot *red*	schwarz *black*	braun *brown*	grün *green*	violett *violet*	grau *gray*	/	weiß/ grün *white/ green*	weiß *white*	braun/ grün *brown/ green*	gelb *yellow*	

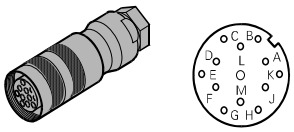
The sensor line is internally connected to the power supply line. External shield lies on housing.
ROD 1030/ERN 1030 without inverted signals $\overline{Ua1}$, $\overline{Ua2}$ and $\overline{Ua0}$.

TTL **

12-pol. Flanschdose
(Typ Binder)
12-pin flange socket
(model: Binder)



12-pol. Stecker
(gerade oder abgewinkelt)
(Typ Binder)
12-pin connector
(straight or offset)
(model: Binder)

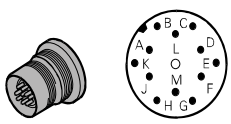


A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**/**	**Gehäuse *Housing***
$\overline{Ua2}$	**5V *** Sensor	**Ua0**	**$\overline{Ua0}$**	**Ua1**	**$\overline{Ua1}$**	**$\overline{UaS}$**	**Ua2**	**frei *free***	**0V** (U_N)	**0V** Sensor	**5V** (Up)	**frei *free***	**Außen-schirm *External shield***
rosa *pink*	blau *blue*	rot *red*	schwarz *black*	braun *brown*	grün *green*	violett *violet*	grau *grey*	/	weiß/ grün *white/ green*	weiß *white*	braun/ grün *brown/ green*	gelb *yellow*	

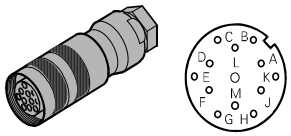
The sensor line is internally connected to the power supply line. Shield on housing.
* Power supply of ERN 460: 10 - 30 V. ** Adapter cable on request

HTL

12-pol. Flanschdose
(Typ Binder)
12-pin flange socket
(model: Binder)



12-pol. Stecker
(gerade oder abgewinkelt)
(Typ Binder)
12-pin connector
(straight or offset)
(model: Binder)

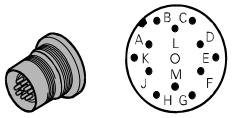


A	B	C	D	E	F	G	H	J	K	L	M	/	Gehäuse *Housing*
—— **Ua2**	**10-30 V** Sensor	**Ua0**	—— **Ua0**	**Ua1**	—— **Ua1**	—— **UaS**	**Ua2**	**frei** ***free***	**0V** (U_N)	**0V** Sensor	**10-30 V** (Up)	**frei** ***free***	**Außen-schirm** ***External shield***
rosa *pink*	blau *blue*	rot *red*	schwarz *black*	braun *brown*	grün *green*	violett *violet*	grau *grey*	/	weiß/ grün *white/ green*	weiß *white*	braun/ grün *brown/ green*	gelb *yellow*	

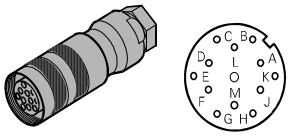
The sensor line is internally connected to the power supply line. External shield lies on housing.

1 Vpp

12-pol. Flanschdose
(Typ Binder)
12-pin flange socket
(model: Binder)



12-pol. Stecker
(gerade oder abgewinkelt)
(Typ Binder)
12-pin connector
(straight or offset)
(model: Binder)



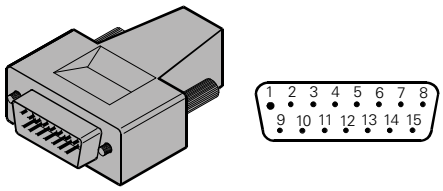
A	B	C	D	E	F	G	H	J	K	L	M	/	Gehäuse *Housing*
B	**5V** Sensor	**R**	**R**	**A**	**A**	**frei** ***free***	**B**	**frei** ***free***	**0V** (U_N)	**0V** Sensor	**5V** (Up)	**frei** ***free***	**Außen-schirm** ***External shield***
–		+	–	+	–		+						
rosa *pink*	blau *blue*	rot *red*	schwarz *black*	braun *brown*	grün *green*	violett *violet*	grau *grey*	/	weiß/ grün *white/ green*	weiß *white*	braun/ grün *brown/ green*	gelb *yellow*	

The sensor line is internally connected to the power supply line. External shield lies on housing.

EXE output signals TTL

EXE 604C
15-pol. Sub-D-Stecker
(Farbangaben gelten für HEIDENHAIN-Kabel)

EXE 604C
15-pin D-Sub connector
(colors apply for HEIDENHAIN cable)

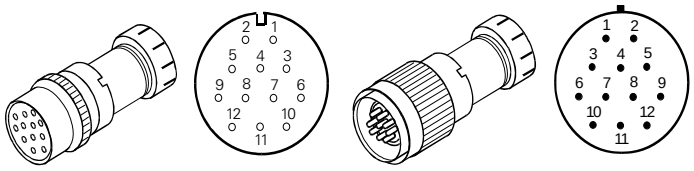


1	2	3	4	5	6	7	8	9	10	11	12
Ua1	**$\overline{Ua1}$**	**Ua2**	**$\overline{Ua2}$**	**5V Sensor**	**Ua0**	**$\overline{Ua0}$**	**$\overline{UaS}$**	**5V Up**	**0V Sensor**	**frei** ***free***	**0V U_N**
braun *brown*	grün *green*	grau *grey*	rosa *pink*	blau *blue*	rot *red*	schwarz *black*	violett *violet*	braun/ grün *brown/ green*	weiß *white*	/	weiß/ grün *white/ green*

The sensor line is internally connected to the power supply line. External shield lies on housing.

EXE 605S: 12-pol. Kupplung (Souriau)
EXE 604C: 12-pol. Stecker (Souriau)
(Farbangaben gelten für HEIDENHAIN-Kabel)

EXE 605S: 12-pin coupling (Souriau)
EXE 604C: 12-pin connector (Souriau)
(colors apply for HEIDENHAIN cables)

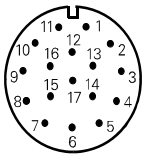


1	2	3	4	5	6	7	8	9	10	11	12
Ua1	**$\overline{\text{Ua1}}$**	**Ua2**	**$\overline{\text{Ua2}}$**	**5V Sensor**	**Ua0**	**$\overline{\text{Ua0}}$**	**$\overline{\text{UaS}}$**	**5V Up**	**0V Sensor**	**Schirm *Shield***	**0V U_N**
braun *brown*	grün *green*	grau *grey*	rosa *pink*	blau *blue*	rot *red*	schwarz *black*	violett *violet*	braun/ grün *brown/ green*	weiß *white*	/	weiß/ grün *white/ green*

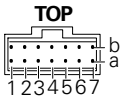
9.7 Drive Encoders and Absolute Encoders

1 Vpp encoder with Zn/Z1 track

17-pol. HEIDENHAIN-Flanschdose
17-pin HEIDENHAIN flange socket



Platinenstecker am Messgerät:
PCB connector on encoder:

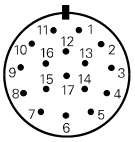


	15	16	12	13	3	2	7	10	1	4
	6b	2a	3b	5a	4b	4a	1b	5b	7a	3a
	A		B		R		5 V UP	0 V UN	5 V Sensor	0 V Sensor
	+	–	+	–	+	–				
	grün / schwarz *green/ black*	gelb / schwarz *yellow/ black*	blau / schwarz *blue/ black*	rot / schwarz *red/ black*	rot *red*	schwarz *black*	braun / grün *brown/ green*	weiß / grün *white/ green*	blau *blue*	weiß *white*

	11	14	17	9	8	5	6
	-	7b	1a	2b	6a	-	-
	Innen-Schirm *Internal shield*	C		D		Temperatur *Temperature*	
		+	–	+	–	+	–
	-	grau *grey*	rosa *pink*	gelb *yellow*	violett *violet*	grün *green*	braun *brown*

1 Vpp encoder (ERM/ERA) with 1 Vpp interface

17-pol. Flanschdose
17-pin flange socket

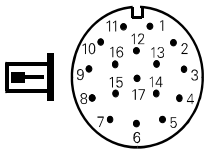
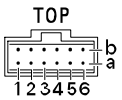


	7	15	10	16	1	2	11	12	3	13
	0 V UN	0 V Sensor	+ V UP	+ V Sensor	A+	A-	B+	B-	R+	R-
	weiß / grün *white/ green*	weiß *white*	braun / grün *brown/ green*	blau *blue*	grün / schwarz *green/ black*	gelb / schwarz *yellow/ black*	blau / schwarz *blue/ black*	rot / schwarz *red/ black*	rot *red*	schwarz *black*

	8	9	4	5	6	14	17
	Temp.+	Temp.-	frei free	frei free	frei free	frei free	frei free
	braun *brown*	weiß *white*	braun *brown*	grün *green*	grau *grey*	rosa *pink*	gelb *yellow*

The sensor line is internally connected to the power supply line. External shield lies on housing.

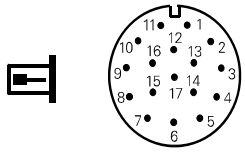
1 Vpp encoder with EnDat or SSI interface

17-pol. HEIDENHAIN-Flanschdose 17-pin HEIDENHAIN flange socket		**Platinenstecker am Messgerät:** ***PCB connector on encoder:***		

	15	16	12	13	14	17	8	9	7	10
	2a	5b	4a	3b	6b	1a	2b	5a	1b	4b
	A		B		DATA	$\overline{\text{DATA}}$	CLOCK	$\overline{\text{CLOCK}}$	5 V UP	0 V UN
	+	–	+	–						
	grün / schwarz *green/ black*	gelb / schwarz *yellow/ black*	blau / schwarz *blue/ black*	rot / schwarz *red/ black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*	braun / grün *brown/ green*	weiß / grün *white/ green*

	11	1	4	3	2	5	6
	-	6a	3a	-	-	-	-
	Innen-Schirm *Internal shield*	5 V Sensor	0 V Sensor	frei *free*	frei *free*	frei *free*	frei *free*
	-	blau *blue*	weiß *white*	rot *red*	schwarz *black*	grün *green*	braun *brown*

1 Vpp encoder with programmable SSI interface (SSI 09 or SSI 10)

17-pol. HEIDENHAIN-Flanschdose ***17-pin HEIDENHAIN flange socket***	

	15	16	12	13	14	17	8	9	7	10
	A		B		DATA	$\overline{\text{DATA}}$	CLOCK	$\overline{\text{CLOCK}}$	10-30V UP	0 V UN
	+	–	+	–						
	grün / schwarz *green/ black*	gelb / schwarz *yellow/ black*	blau / schwarz *blue/ black*	rot / schwarz *red/ black*	grau *grey*	rosa *pink*	violett *violet*	gelb *yellow*	braun / grün *brown/ green*	weiß / grün *white/ green*

	11	1	4	3	2	5	6
	Innen-Schirm *Internal shield*	RxD	TxD	$\overline{\text{UaS}}$ [1]	Dreh-richtung *Rotational direction*	Preset1	Preset2
	-	blau *blue*	weiß *white*	rot *red*	schwarz *black*	grün *green*	braun *brown*

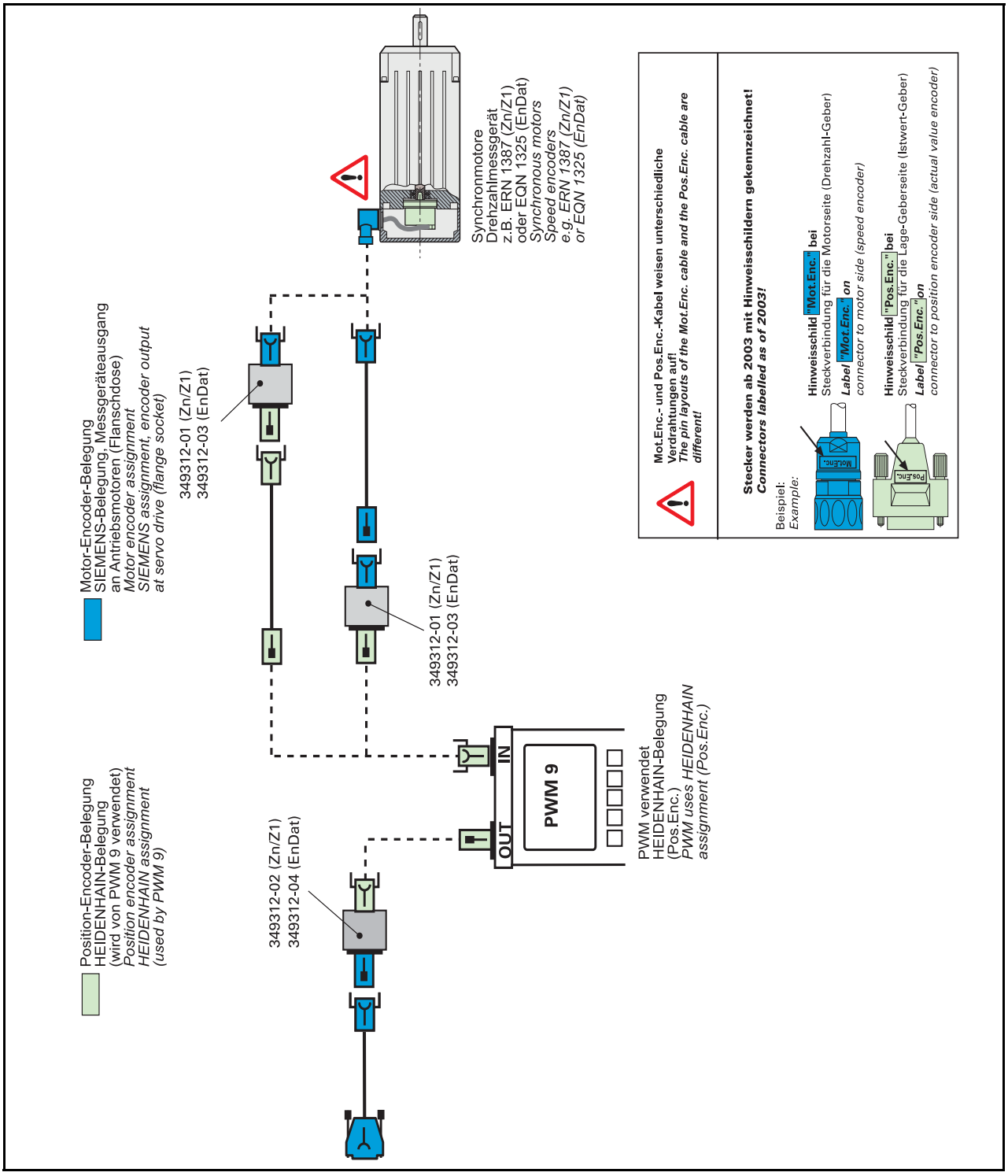
1) Encoder error signal; displayed by PWM 9 as $\overline{\text{UaS2}}$ (see also 1 Vpp encoders with prog. SSI interface)

9.8 Adapter (Assignment Converter) for Non-HEIDENHAIN Wiring

Attention

Please check the pin assignment!
If a motor encoder is assigned (e.g. flange socket, encoder output on motors) the adapter (assignment converter) ID 349312-xx must be inserted. If the adapters are not used, the motor encoder may be destroyed!

Example:
Adaptation of the PWM 9 interface boards with HEIDENHAIN Pos.Enc. (position encoder) wiring to a motor encoder with SIEMENS wirings Mot.Enc.



Adapter connector Zn/Z1 ID 349312-01 transforming Mot.Enc. into Pos.Enc.

Zn/Z1 IN	**PWM 9-Seite (Pos.Enc. 1Vss)** ***PWM 9 side (Pos.Enc.1Vpp)***	**Signal**	**Farbe** ***Color***	**Motor-Seite (Mot.Enc. 1Vss)** ***Drive side (Mot.Enc.1Vpp)***
	Flanschdose 17-pol. Stift *Flange socket 17-pin, male*			Flanschdose 17-pol. Überwurf Buchse *Flange socket 17-pin, knurled coupling ring*
	PIN 1	U_P - Sensor	blau / *blue*	PIN 16
	PIN 2	R-	schwarz / *black*	PIN 13
	PIN 3	R+	rot / *red*	PIN 3
	PIN 4	0V - Sensor	weiß / *white*	PIN 15
	PIN 5	Temp.+	grün / *green*	PIN 8
	PIN 6	Temp.-	braun / *brown*	PIN 9
	PIN 7	U_P	braun/grün *brown/green*	PIN 10
	PIN 8	D-	violett / *violet*	PIN 4
	PIN 9	D+	gelb / *yellow*	PIN 14
	PIN 10	0V	weiß/grün *white/green*	PIN 7
349312-01	PIN 11	Innenschirm *Internal shield*	-	PIN 17
	PIN 12	B+	blau/schwarz *blue/black*	PIN 11
	PIN 13	B-	rot/schwarz *red/black*	PIN 12
	PIN 14	C+	grau / *grey*	PIN 5
	PIN 15	A+	grün/schwarz *green/black*	PIN 1
	PIN 16	A-	gelb/schwarz *yellow/black*	PIN 2
	PIN 17	C-	rosa / *pink*	PIN 6

Adapter connector Zn/Z1 ID 349312-02 transforming Pos.Enc. into Mot.Enc.

Zn/Z1 OUT	**Motor-Seite (Mot.Enc. 1Vss)** ***Drive side (Mot.Enc.1Vpp)***	**Signal**	**Farbe** ***Color***	**PWM 9-Seite (Pos.Enc. 1Vss)** ***PWM 9 side (Pos.Enc.1Vpp)***
	Flanschdose 17-pol. Stift *Flange socket 17-pin, male*			Flanschdose 17-pol. Überwurf Buchse *Flange socket 17-pin, knurled coupling ring*
	PIN 16	U_P – Sensor	blau / *blue*	PIN 1
	PIN 13	R-	schwarz / *black*	PIN 2
	PIN 3	R+	rot / *red*	PIN 3
	PIN 15	0V – Sensor	weiß / *white*	PIN 4
	PIN 8	Temp.+	grün / *green*	PIN 5
	PIN 9	Temp. -	braun / *brown*	PIN 6
	PIN 10	U_P	braun/grün *brown/green*	PIN 7
	PIN 4	D-	violett / *violet*	PIN 8
	PIN 14	D+	gelb / *yellow*	PIN 9
	PIN 7	0V	weiß/grün *white/green*	PIN 10
	PIN 17	Innenschirm *Internal shield*	-	PIN 11
349312-02	PIN 11	B+	blau/schwarz *blue/black*	PIN 12
	PIN 12	B-	rot/schwarz *red/black*	PIN 13
	PIN 5	C+	grau / *grey*	PIN 14
	PIN 1	A+	grün/schwarz *green/black*	PIN 15
	PIN 2	A-	gelb/schwarz *yellow/black*	PIN 16
	PIN 6	C-	rosa / *pink*	PIN 17

Adapter connector EnDat/SSI ID 349312-03 transforming Mot.Enc. into Pos.Enc.

EnDat/SSI IN	**PWM 9 Seite (Pos.Enc.EnDat)** ***PWM 9 side (Pos.Enc.EnDat)***	**Signal**	**Farbe** ***Color***	**Motor-Seite (Mot.Enc.EnDat)** ***Drive side (Mot.Enc.EnDat)***
	Flanschdose 17-pol. Stift *Flange socket 17-pin, male*			Flanschdose 17-pol. Überwurf Buchse *Flange socket 17-pin, knurled coupling ring*
	PIN 1	U_P – Sensor	blau / *blue*	PIN 16
	PIN 2	frei / *free*		
	PIN 3	frei / *free*		
	PIN 4	0V – Sensor	weiß / *white*	PIN 15
	PIN 5	Temp.+	grün / *green*	PIN 8
	PIN 6	Temp.-	braun / *brown*	PIN 9
	PIN 7	U_P	braun/grün *brown/green*	PIN 10
	PIN 8	CLOCK+	violett / *violet*	PIN 5
	PIN 9	CLOCK-	gelb / *yellow*	PIN 14
	PIN 10	0V	weiß/grün *white/green*	PIN 7
	PIN 11	Innenschirm *Internal shield*	-	PIN 17
349312-03	PIN 12	B+	blau/schwarz *blue/black*	PIN 11
	PIN 13	B-	rot/schwarz *red/black*	PIN 12
	PIN 14	DATA+	grau / *grey*	PIN 3
	PIN 15	A+	grün/schwarz *green/black*	PIN 1
	PIN 16	A-	gelb/schwarz *yellow/black*	PIN 2
	PIN 17	DATA-	rosa / *pink*	PIN 13

Adapter connector EnDat/SSI ID 349312-04 transforming Pos.Enc. into Mot.Enc.

EnDat/SSI OUT	**Motor-Seite (Mot.Enc.EnDat)** ***Drive side (Mot.Enc.EnDat)***	**Signal**	**Farbe** ***Color***	**PWM 9 Seite (Pos.Enc.EnDat)** ***PWM 9 side (Pos.Enc.EnDat)***
	Flanschdose 17-pol. Stift *Flange socket 17-pin, male*			Flanschdose 17-pol. Überwurf Buchse *Flange socket 17-pin, knurled coupling ring*
	PIN 16	U_P – Sensor	blau / *blue*	PIN 1
		frei / *free*		
		frei / *free*		
	PIN 15	0V – Sensor	weiß / *white*	PIN 4
	PIN 8	Temp.+	grün / *green*	PIN 5
	PIN 9	Temp.-	braun / *brown*	PIN 6
	PIN 10	U_P	braun/grün *brown/green*	PIN 7
	PIN 5	CLOCK+	violett / *violet*	PIN 8
	PIN 14	CLOCK-	gelb / *yellow*	PIN 9
	PIN 7	0V	weiß/grün *white/green*	PIN 10
349312-04	PIN 17	Innenschirm *Internal shield*	-	PIN 11
	PIN 11	B+	blau/schwarz *blue/black*	PIN 12
	PIN 12	B-	rot/schwarz *red/black*	PIN 13
	PIN 3	DATA+	grau / *grey*	PIN 14
	PIN 1	A+	grün/schwarz *green/black*	PIN 15
	PIN 2	A-	gelb/schwarz *yellow/black*	PIN 16
	PIN 13	DATA-	rosa / *pink*	PIN 17

9.9 Adapter Cable for Connecting the PWM to the PCB Connector of the Encoder

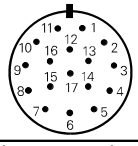
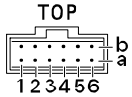
If the encoder is to be tested while the type of cable assembly is unknown, the adapter cable with HEIDENHAIN layout has to be connected directly to the PCB connector of the encoder.

Note

The 17-pin right-angle flange socket of the drive (encoder) may have different layouts.

Adapter with 12-pin PCB connector

Application: Absolute encoders with EnDat or SSI interface

Adapterkabel ID 349839-xx / EnDat/SSI ***Adapter cable ID 349839-xx / EnDat/SSI***			
	**Signal**	**Farbe** ***Color***	
Kupplung 17-pol. Stift *Coupling 17-pin, male*			Platinenstecker 12-pol. *PCB connector 12-pin*
PIN 1	U_P – Sensor	blau / *blue*	6a
PIN 2	frei / *free*	schwarz / *black*	-
PIN 3	frei / *free*	rot / *red*	-
PIN 4	0V – Sensor	weiß / *white*	3a
PIN 5	Temp.+	grün / *green*	-
PIN 6	Temp.-	braun / *brown*	-
PIN 7	U_P	braun/grün *brown/green*	1b
PIN 8	CLOCK+	violett / *violet*	2b
PIN 9	CLOCK-	gelb / *yellow*	5a
PIN 10	0V	weiß/grün *white/green*	4b
PIN 11	Innenschirm *Internal shield*	-	-
PIN 12	B+	blau/schwarz *blue/black*	4a
PIN 13	B-	rot/schwarz *red/black*	3b
PIN 14	DATA+	grau / *grey*	6b
PIN 15	A+	grün/schwarz *green/black*	2a
PIN 16	A-	gelb/schwarz *yellow/black*	5b
PIN 17	DATA-	rosa / *pink*	1a

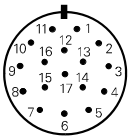
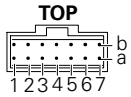
Attention

This cable is not suitable for feed-through operation at the machine, since there are no lines for temperature monitoring! Observe the shielding!

Adapter with 14-pin PCB connector

Application: Incremental encoders with incremental track Zn (A, B) and commutating track Z1 (C, D)

Adapterkabel ID 330980-xx / Zn/Z1
Adapter cable ID 330980-xx / Zn/Z1

	**Signal**	**Farbe** ***Color***	
Kupplung 17-pol. Stift *Coupling 17-pin, male*			Platinenstecker 14-pin *PCB connector 14-pin*
PIN 1	U_P – Sensor	blau / *blue*	7a
PIN 2	R-	schwarz / *black*	4a
PIN 3	R+	rot / *red*	4b
PIN 4	0V – Sensor	weiß / white	3a
PIN 5	Temp.+	grün / *green*	-
PIN 6	Temp. -	braun / *brown*	-
PIN 7	U_P	braun/grün *brown/green*	1b
PIN 8	D-	violett /*violet*	6a
PIN 9	D+	gelb / *yellow*	2b
PIN 10	0V	weiß/grün *white/green*	5b
PIN 11	Innenschirm *Internal shield*	-	-
PIN 12	B+	blau/schwarz *blue/black*	3b
PIN 13	B -	rot/schwarz *red/black*	5a
PIN 14	C+	grau / *grey*	7b
PIN 15	A+	grün/schwarz *green/black*	6b
PIN 16	A-	gelb/schwarz *yellow/black*	2a
PIN 17	C-	rosa / *pink*	1a

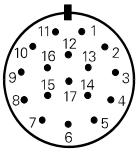
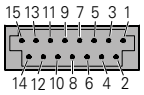
Attention

This cable is not suitable for feed-through operation at the machine, since there are no lines for temperature monitoring!

Observe the shielding!

Adapter with 15-pin PCB connector

Application: Absolute encoders with EnDat interface

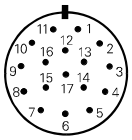
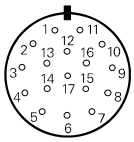
Adapterkabel ID 635349-xx ***Adapter cable ID 635349-xx***			
	**Signal**	**Farbe** ***Color***	
Kupplung 17-pol. Stift *Coupling 17-pin, male*			Platinenstecker 15-pol. *PCB connector 15-pin*
PIN 1	U_P – Sensor	blau / *blue*	11
PIN 2	frei / *free*	schwarz / *black*	-
PIN 3	frei / *free*	rot / *red*	-
PIN 4	0V – Sensor	weiß / *white*	12
PIN 5	Temp.+	grün / *green*	5
PIN 6	Temp.-	braun / *brown*	6
PIN 7	U_P	braun/grün *brown/green*	13
PIN 8	CLOCK+	violett / *violet*	9
PIN 9	CLOCK-	gelb / *yellow*	10
PIN 10	0V	weiß/grün *white/green*	14
PIN 11	Innenschirm *Internal shield*	-	-
PIN 12	B+	blau/schwarz *blue/black*	3
PIN 13	B-	rot/schwarz *red/black*	4
PIN 14	DATA+	grau / *grey*	7
PIN 15	A+	grün/schwarz *green/black*	1
PIN 16	A-	gelb/schwarz *yellow/black*	2
PIN 17	DATA-	rosa / *pink*	8

Attention

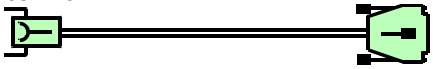
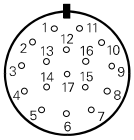
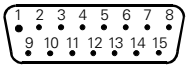
This cable is not suitable for feed-through operation at the machine, since there are no lines for temperature monitoring!

Observe the shielding!

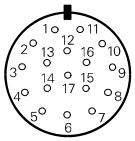
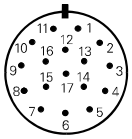
9.10 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Pos.Enc.EnDat)

Adapterkabel ID 323897-xx ***Adapter cable ID 323897-xx***			
Pos.Enc. Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
Kupplung 17-pol. Stift *Coupling 17-pin, male*			Stecker 17-pol. Buchse *Connector 17-pin, female*
PIN 1	U_P – Sensor oder / *or* RxD	blau / *blue*	PIN 1
PIN 2	R- Drehrichtung *R- Rotational direction*	schwarz / *black*	PIN 2
PIN 3	R+ oder / *or* $\overline{\text{UaS}}$	rot / *red*	PIN 3
PIN 4	0V – Sensor oder /*or* TxD	weiß / *white*	PIN 4
PIN 5	Temp.+ Preset1	grün / *green*	PIN 5
PIN 6	Temp.-Preset2	braun / *brown*	PIN 6
PIN 7	U_P	braun/grün *brown/green*	PIN 7
PIN 8	CLOCK+	violett / *violet*	PIN 8
PIN 9	CLOCK-	gelb / *yellow*	PIN 9
PIN 10	0V	weiß/grün *white/green*	PIN 10
PIN 11	Innenschirm *Internal shield*	-	PIN 11
PIN 12	B+	blau/schwarz *blue/black*	PIN 12
PIN 13	B-	rot/schwarz *red/black*	PIN 13
PIN 14	DATA+	grau / *grey*	PIN 14
PIN 15	A+	grün/schwarz *green/black*	PIN 15
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 16
PIN 17	DATA-	rosa / *pink*	PIN 17
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

9.11 Adapter Cable to IK 115 / IK 215 Interface Card

Adapterkabel ID 324544-xx ***Adapter cable ID 324544-xx***			
Pos.Enc.  Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. Buchse *17-pin female connector*			Sub-D-Stecker 15-pol. Stift *15-pin D-sub connector, male*
PIN 1	U_P Sensor	blau / *blue*	PIN 12
PIN 2	frei / *free*	-	PIN 7
PIN 3	frei / *free*	-	PIN 14
PIN 4	0V Sensor	weiß / *white*	PIN 10
PIN 5	frei / *free*	-	-
PIN 6	frei / *free*	-	-
PIN 7	U_P	braun/grün *brown/green*	PIN 4
PIN 8	CLOCK+	violett / *violet*	PIN 8
PIN 9	CLOCK-	gelb / *yellow*	PIN 15
PIN 10	0V (U_N)	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm *Internal shield*	-	PIN 6
PIN 12	B+	blau/schwarz *blue/black*	PIN 3
PIN 13	B-	rot/schwarz *red/black*	PIN 11
PIN 14	DATA+	grau / *grey*	PIN 5
PIN 15	A+	grün/schwarz *green/black*	PIN 1
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 9
PIN 17	DATA-	rosa / *pink*	PIN 13
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

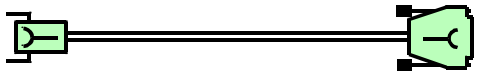
9.12 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Mot.Enc.EnDat)

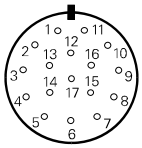
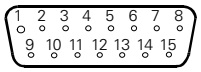
Adapterkabel ID 340302-xx ***Adapter cable ID 340302-xx***			
	Mot.Enc. Mot.Enc.		
	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. Buchse *17-pin female connector*			Kupplung 17-pol. Stift *17-pin male coupling*
PIN 1	A+	grün/schwarz *green/black*	PIN 1
PIN 2	A-	gelb/schwarz *yellow/black*	PIN 2
PIN 3	DATA+	rot / *red*	PIN 3
PIN 4	frei / *free*	-	PIN 4
PIN 5	CLOCK+	grün / *green*	PIN 5
PIN 6	frei / *free*	-	PIN 6
PIN 7	0V (U_N)	weiß/grün *white/green*	PIN 7
PIN 8	Temp+	gelb / yellow	PIN 8
PIN 9	Temp –	violett / *violet*	PIN 9
PIN 10	+V (U_P)	braun/grün *brown/green*	PIN 10
PIN 11	B+	blau/schwarz *blue/black*	PIN 11
PIN 12	B-	rot/schwarz *red/black*	PIN 12
PIN 13	DATA -	schwarz / *black*	PIN 13
PIN 14	CLOCK -	braun / *brown*	PIN 14
PIN 15	0 V Sensor	weiß / *white*	PIN 15
PIN 16	+V Sensor	blau / *blue*	PIN 16
PIN 17	Innenschirm (0 V) *Internal shield (0 V)*	-	PIN 17
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

9.13 Adapter Cable 17-Pin/15-Pin; PWM to Subsequent Electronics (Pos.Enc.EnDat)

Adapterkabel ID 332115-xx
Adapter cable ID 332115 -xx

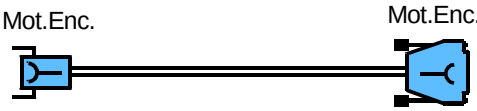
Pos.Enc. Pos.Enc.

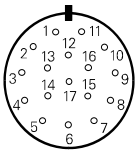
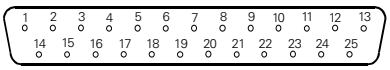


	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. Buchse *17-pin female connector*			Sub-D-Stecker 15-pol. Buchse *15-pin D-sub connector, female*
PIN 1	Up Sensor	blau / *blue*	PIN 9
PIN 4	0V Sensor	weiß / *white*	PIN 11
PIN 7	Up	braun/grün *brown/green*	PIN 1
PIN 8	CLOCK+	violett / *violet*	PIN 14
PIN 9	CLOCK-	gelb / *yellow*	PIN 15
PIN 10	0V (U_N)	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm *Internal shield*	Innenschirm *Internal shield*	PIN 13
PIN 12	B+	blau/schwarz *blue/black*	PIN 6
PIN 13	B-	rot/schwarz *red/black*	PIN 7
PIN 14	DATA+	grau / *grey*	PIN 5
PIN 15	A+	grün/schwarz *green/black*	PIN 3
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 17	DATA-	rosa / *pink*	PIN 8
PIN 2	frei / *free*	-	10
PIN 3			12
PIN 5			
PIN 6			
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

9.14 Adapter Cable 17-Pin/25-Pin; PWM to Subsequent Electronics (Mot.Enc.1 Vpp)

Adapterkabel ID 289440-xx
Adapter cable ID 289440-xx



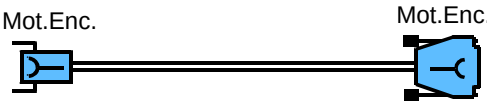
	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. Buchse *17-pin female connector*			Sub-D-Stecker 25-pol. Buchse *25-pin D-sub connector (female)*
PIN 1	A+	grün/schwarz *green/black*	PIN 3
PIN 2	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 3	R+	rot / *red*	PIN 17
PIN 4	D-	rosa / *pink*	PIN 22
PIN 5	C+	grün / *green*	PIN 19
PIN 6	C-	braun / *brown*	PIN 20
PIN 7	0V (U_N)	weiß/grün *white/green*	PIN 2
PIN 8	Temp+	gelb / *yellow*	PIN 13
PIN 9	Temp-	violett / *violet*	PIN 25
PIN 10	+V (U_P)	braun/grün *brown/green*	PIN 1
PIN 11	B+	blau/schwarz *blue/black*	PIN 6
PIN 12	B-	rot/schwarz *red/black*	PIN 7
PIN 13	R -	schwarz / *black*	PIN 18
PIN 14	D+	grau / *gray*	PIN 21
PIN 15	0 V Sensor	weiß / *white*	PIN 16
PIN 16	+5 V Sensor	blau / *blue*	PIN 14
PIN 17	Innenschirm (0 V) *Internal shield (0 V)*	Innenschirm *Internal shield*	PIN 8
-	frei / *free*	-	PIN 5
-	frei / *free*	-	PIN 9
-	frei / *free*	-	PIN 10
-	frei / *free*	-	PIN 11
-	frei / *free*	-	PIN 12
-	frei / *free*	-	PIN 15
-	frei / *free*	-	PIN 23
-	frei / *free*	-	PIN 24
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

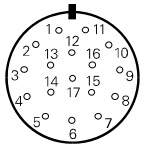
Note

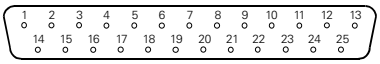
This adapter cable can only be used with the adapter Zn/Z1 ID 349312-01/02 at the 1 Vpp absolute interface board ID 312186-xx.

9.15 Adapter Cable 17-Pin/25-Pin; PWM to Subsequent Electronics (Mot.Enc.EnDat)

Adapterkabel ID 336376-xx
Adapter cable ID 336376-xx



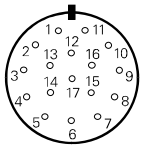
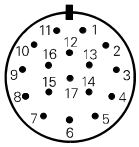


Signal	**Farbe** ***Color***	
		Sub-D-Stecker 25-pol. Buchse *25-pin D-sub connector (female)*
A+	grün/schwarz *green/black*	PIN 3
A-	gelb/schwarz *yellow/black*	PIN 4
DATA+	rot / *red*	PIN 15
frei / *free*	-	-
CLOCK+	grün / *green*	PIN 10
frei / *free*	-	-
0V (U_N)	weiß/grün *white/green*	PIN 2
Temp+	gelb / *yellow*	PIN 13
Temp-	violett / *violet*	PIN 25
+V (U_P)	braun/grün *brown/green*	PIN 1
B+	blau/schwarz *blue/black*	PIN 6
B-	rot/schwarz *red/black*	PIN 7
DATA-	schwarz / *black*	PIN 23
CLOCK-	braun / *brown*	PIN 12
0 V Sensor	weiß / *white*	PIN 16
+ V Sensor	blau / *blue*	PIN 14
Innenschirm (0 V) *Internal shield (0 V)*	-	PIN 8
frei / *free*	-	PIN 5
frei / *free*	-	PIN 9
frei / *free*	-	PIN 11
frei / *free*	-	PIN 17
frei / *free*	-	PIN 18
frei / *free*	-	PIN 19
frei / *free*	-	PIN 20
frei / *free*	-	PIN 21
frei / *free*	-	PIN 22
frei / *free*	-	PIN 24
Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

Note

This adapter cable can only be used with the adapter EnDat/SSI ID 349312-03/04 at the 1 Vpp absolute interface board ID 312186-xx.

9.16 Adapter Cable 17-Pin/17-Pin; PWM to Motor (Mot.Enc.1 Vpp)

Adapterkabel ID 336847-xx ***Adapter cable ID 336847-xx***			
Mot.Enc. Mot.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 17- pol. Buchse *17- pin female connector*			Kupplung 17- pol. Stift *17- pin male coupling*
PIN 1	A+	grün/schwarz *green/black*	PIN 1
PIN 2	A-	gelb/schwarz *yellow/black*	PIN 2
PIN 3	R+	rot /*red*	PIN 3
PIN 4	D-	rosa /*pink*	PIN 4
PIN 5	C+	grün /*green*	PIN 5
PIN 6	C-	braun /*brown*	PIN 6
PIN 7	0V (U_N)	weiß/grün *white/green*	PIN 7
PIN 8	Temp +	gelb /*yellow*	PIN 8
PIN 9	Temp -	violett /*violet*	PIN 9
PIN 10	+V (U_P)	braun/grün *brown/green*	PIN 10
PIN 11	B+	blau/schwarz *blue/black*	PIN 11
PIN 12	B-	rot/schwarz *red/black*	PIN 12
PIN 13	R-	schwarz /*black*	PIN 13
PIN 14	D+	grau / grey	PIN 14
PIN 15	0 V Sensor	weiß /*white*	PIN 15
PIN 16	+V Sensor	blau /*blue*	PIN 16
PIN 17	Innenschirm (0 V) *Internal shield (0 V)*	-	PIN 17
Steckergehäuse *Connector housing*	Außenschirm *External shield*	Außenschirm *External shield*	Steckergehäuse *Connector housing*

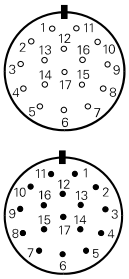
Note

This adapter cable can only be used with the adapter Zn/Z1 ID 349312-01/02 at the 1 Vpp absolute interface board ID 312186-xx.

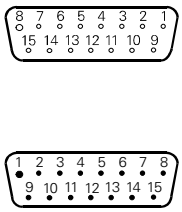
9.17 Adapter Cable 17-Pin/15-Pin; TNC with 15-Pin D-Sub Connector (Pos.Enc. 1 Vpp/EnDat)

Adapterkabel ID 510616-xx
Adapter cable ID 510616-xx

Adapterkabel ID 510617-xx
Adapter cable ID 510617-xx



Signal 1 Vss ***Signal 1 Vpp***	**Signal EnDat** ***Signal EnDat***	**Farbe** ***Color***



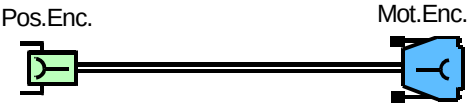
Stecker 17-pol. *17-pin connector*				Sub-D-Stecker 15-pol. *15-pin D-sub connector*
PIN 1	Sensor+	Sensor+	blau / *blue*	PIN 9
PIN 2	R-	nicht verwendet *not used*	schwarz/ *black*	PIN 12
PIN 3	R+	nicht verwendet *not used*	rot / *red*	PIN 10
PIN 4	Sensor-	Sensor-	weiß / *white*	PIN 11
PIN 5	Temp+	nicht verwendet *not used*	Leitung vom externen Temperaturfühler *Wire from external temperature sensor*	
PIN 6	Temp-	nicht verwendet *not used*	Leitung vom externen Temperaturfühler *Wire from external temperature sensor*	
PIN 7	+5 V (U_P)	+5 V	braun/grün *brown/green*	PIN 1
PIN 8	nicht verwendet *not used*	CLOCK+	violett / *violet*	PIN 14
PIN 9	nicht verwendet *not used*	CLOCK-	gelb / *yellow*	PIN 15
PIN 10	0 V (U_N)	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm (0 V) *Internal shield (0 V)*	Innenschirm (0 V) *Internal shield (0 V)*		PIN 13
PIN 12	B+	B+	blau/schwarz *blue/black*	PIN 6
PIN 13	B-	B-	rot/schwarz *red/black*	PIN 7
PIN 14	-	DATA+	grau / *grey*	PIN 5
PIN 15	A+	A+	grün/schwarz *green/black*	PIN 3
PIN 16	A-	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 17	-	DATA-	rosa / *pink*	PIN 8
Steckergehäuse *Connectorhousing*	Außenschirm *External shield*	Außenschirm *External shield*		Steckergehäuse *Connectorhousing*

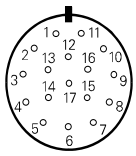
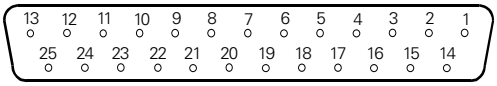
Note

This adapter cable is for use with encoders with 15-pin D-sub EnDat and 15-pin D-sub 1 Vpp connectors.
For the EnDat setting the 1 Vpp absolute interface card must be set to **SSI/EnDat**.
For the 1 Vpp setting set the 1 Vpp absolute interface card to **1 Vpp**.

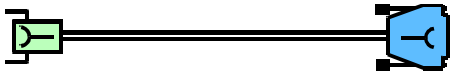
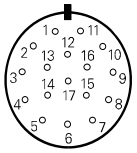
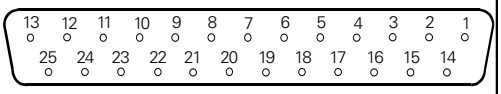
9.18 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/ZnZ1)

Adapterkabel ID 511886-xx
Adapter cable ID 511886-xx

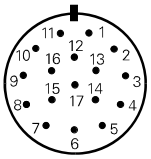
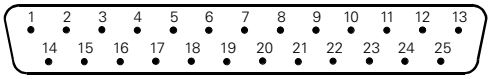


	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. *17-pin connector*			Sub-D-Stecker 25-pol. *25-pin D-sub connector*
PIN 1	5 V Sensor (U_P)	blau / *blue*	PIN 14
PIN 2	R-	schwarz / *black*	PIN 18
PIN 3	R+	rot / *red*	PIN 17
PIN 4	0 V Sensor (U_N)	weiß / *white*	PIN 16
PIN 5	Temp+	gelb / *yellow*	PIN 13
PIN 6	Temp-	violett / *violet*	PIN 25
PIN 7	U_P	braun/grün *brown/green*	PIN 1
PIN 8	D-	rosa / *pink*	PIN 22
PIN 9	D+	grau / *grey*	PIN 21
PIN 10	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm *Internal shield*		PIN 8
PIN 12	B+	blau/schwarz *blue/black*	PIN 6
PIN 13	B-	rot/schwarz *red/black*	PIN 7
PIN 14	C+	grün / *green*	PIN 19
PIN 15	A+	grün/schwarz *green/black*	PIN 3
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 17	C-	braun / *brown*	PIN 20
Steckergehäuse *Connector housing*	Außenschirm *External shield*		Steckergehäuse *Connector housing*
	frei / *free*		PIN 9
	frei / *free*		PIN 10
	frei / *free*		PIN 11
	frei / *free*		PIN 12

9.19 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/EnDat)

Adapterkabel ID 509667-xx ***Adapter cable ID 509667-xx***			
Pos.Enc.  Mot.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 17-pol. *17-pin connector*			Sub-D-Stecker 25-pol. *25-pin D-sub connector*
PIN 1	5 V Sensor (U_P)	blau / *blue*	PIN 14
PIN 2	-	schwarz / *black*	
PIN 3	-	rot / *red*	
PIN 4	0 V Sensor (U_N)	weiß / *white*	PIN 16
PIN 5	Temp+	gelb / *yellow*	PIN 13
PIN 6	Temp-	violett / *violet*	PIN 25
PIN 7	U_P	braun/grün *brown/green*	PIN 1
PIN 8	CLOCK+	grün / *green*	PIN 10
PIN 9	CLOCK-	braun / *brown*	PIN 12
PIN 10	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm *Internal shield*		PIN 8
PIN 12	B+	blau/schwarz *blue/black*	PIN 6
PIN 13	B-	rot/schwarz *red/black*	PIN 7
PIN 14	DATA+	rot / *red*	PIN 15
PIN 15	A+	grün/schwarz *green/black*	PIN 3
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 17	DATA-	schwarz / *black*	PIN 23
Steckergehäuse *Connector housing*	Außenschirm *External shield*		Steckergehäuse *Connector housing*
	frei / *free*		PIN 17
	frei / *free*		PIN 18
	frei / *free*		PIN 19
	frei / *free*		PIN 20
	frei / *free*		PIN 21
	frei / *free*		PIN 22

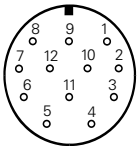
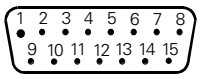
9.20 Adapter Cable 17-Pin/25-Pin; TNC with 25-Pin D-Sub Connector (Pos.Enc./Mot.Enc. 1 Vpp/EnDat and 1 Vpp/ZnZ1)

Adapterkabel ID 509666-xx ***Adapter cable ID 509666-xx***			
Pos.Enc.			Mot.Enc.
	**Signal EnDat und 1 Vss Zn/Z1** ***Signal EnDat and 1 Vpp Zn/Z1***	**Farbe** ***Color***	
Stecker 17-pol. *17-pin connector*			Sub-D-Stecker 25-pol. *25-pin D-sub connector*
PIN 1	5 V Sensor (U_P)	blau / *blue*	PIN 14
PIN 2	R- / -- (EnDat)	schwarz / *black*	PIN 18
PIN 3	R+ / -- (EnDat)	rot / *red*	PIN 17
PIN 4	0 V Sensor (U_N)	weiß / *white*	PIN 16
PIN 5	Temp+	grün / *green*	PIN 13
PIN 6	Temp-	braun / *brown*	PIN 25
PIN 7	U_P	braun/grün *brown/green*	PIN 1
PIN 8	D- / CLOCK+ (EnDat)	violett / *violet*	PIN 22 / 10 (Brücke) *PIN 22 / 10 (bridge)*
PIN 9	D+ / CLOCK- (EnDat)	gelb / *yellow*	PIN 21 / 12 (Brücke) *PIN 21 / 12 (bridge)*
PIN 10	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Innenschirm *Internal shield*		PIN 8
PIN 12	B+	blau/schwarz *blue/black*	PIN 6
PIN 13	B-	rot/schwarz *red/black*	PIN 7
PIN 14	C+ / DATA+ (EnDat)	grau / *grey*	PIN 19 / 15 (Brücke) *PIN 19 / 15 (bridge)*
PIN 15	A+	grün/schwarz *green/black*	PIN 3
PIN 16	A-	gelb/schwarz *yellow/black*	PIN 4
PIN 17	C- / DATA- (EnDat)	rosa / *pink*	PIN 20 / 23 (Brücke) *PIN 20 / 23 (bridge)*
Steckergehäuse *Connector housing*	Außenschirm *External shield*		Steckergehäuse *Connector housing*

9.21 Adapter Cable 12-Pin/15-Pin; PWM to TTL D-Sub Subsequent Electronics (Pos.Enc.)

Note

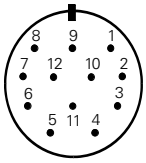
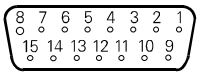
Check the wiring!

Adapterkabel ID 310196-xx ***Adapter cable ID 310196-xx***			
	**Signal**	**Farbe** ***Color***	
Stecker 12-pol. *12-pin connector*			Sub-D-Stecker 15-pol. *15-pin D-sub connector*
PIN 1	-Ua2	rosa / *pink*	PIN 11
PIN 2	Sensor U_P	blau / *blue*	PIN 12
PIN 3	+Ua0	rot / *red*	PIN 14
PIN 4	-Ua0	schwarz / *black*	PIN 7
PIN 5	+Ua1	braun / *brown*	PIN 1
PIN 6	-Ua1	grün / *green*	PIN 9
PIN 7	-UaS [1)]	violett / *violet*	PIN 13
PIN 8	+Ua2	grau / *grey*	PIN 3
PIN 9	frei / *free* [2)]	-	PIN 15
PIN 10	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Sensor 0 V	weiß / *white*	PIN 10
PIN 12	U_P	braun/grün *brown/green*	PIN 4
-	frei / *free*	-	PIN 5
-	frei / *free*	-	PIN 6
-	frei / *free*	-	PIN 8
	abgeschnitten / *cut off*	gelb / *yellow*	
Gehäuse / *Housing*	Schirm / *Shield*		Gehäuse / *Housing*

[1)] LS 323: free

[2)] "Exposed" encoders: TTL/11 µApp switchover for PWT

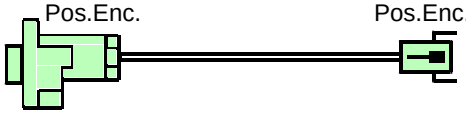
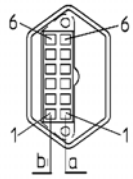
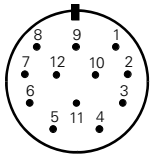
9.22 Adapter Cable 12-Pin/15-Pin; PWM to TTL Interface Electronics (APE) D-Sub (Pos.Enc.)

Adapterkabel ID 355215-xx / 331693-xx ***Adapter cable ID 355215-xx / 331693-xx***			
Pos.Enc. Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 12-pol. *12-pin connector*			Sub-D-Stecker 15-pol. *15-pin D-sub connector*
PIN 1	-Ua2	rosa / *pink*	PIN 11
PIN 2	Sensor U_P	blau / *blue*	PIN 12
PIN 3	+Ua0	rot / *red*	PIN 14
PIN 4	-Ua0	schwarz / *black*	PIN 7
PIN 5	+Ua1	braun / *brown*	PIN 1
PIN 6	-Ua1	grün / *green*	PIN 9
PIN 7	-UaS [1)]	violett / *violet*	PIN 13
PIN 8	+Ua2	grau / *grey*	PIN 3
PIN 9	_ [2)]	gelb / *yellow*	PIN 15
PIN 10	0 V	weiß/grün *white/green*	PIN 2
PIN 11	Sensor 0 V	weiß / *white*	PIN 10
PIN 12	U_P	braun/grün *brown/green*	PIN 4
-	frei / *free*	-	PIN 5
-	frei / *free*	-	PIN 6
-	frei / *free*	-	PIN 8
Gehäuse / *Housing*	Schirm / *Shield*		Gehäuse / *Housing*

[1)] Not used by all JH encoders

[2)] "Exposed" linear encoders: TTL/11 µApp switchover (adjustment/ testing)

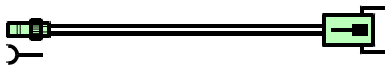
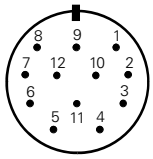
9.23 Adapter Cable 12-Pin/12-Pin; PWM to TTL Interface Electronics (APE) (Pos.Enc.)

Adapterkabel ID 323466-xx ***Adapter cable ID 323466-xx***			
Pos.Enc.  Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
APE-12-pol. *12-pin APE*			Stecker 12-pol. *12-pin connector*
PIN 5a	-Ua2	rosa / *pink*	PIN 1
PIN 2b	Sensor U_P	blau / *blue*	PIN 2
PIN 4b	+Ua0	rot / *red*	PIN 3
PIN 4a	-Ua0	schwarz / *black*	PIN 4
PIN 6b	+Ua1	braun / *brown*	PIN 5
PIN 6a	-Ua1	grün / *green*	PIN 6
PIN 3a	-UaS [1]	violett / *violet*	PIN 7
PIN 5b	+Ua2	grau / *grey*	PIN 8
PIN 3b	– [2]	gelb / *yellow*	PIN 9
PIN 1a	0 V	weiß/grün *white/green*	PIN 10
PIN 1b	Sensor 0 V	weiß / *white*	PIN 11
PIN 2a	U_P	braun/grün *brown/green*	PIN 12
Gehäuse / *Housing*	frei / *free*		Gehäuse / *Housing*

[1] Not used by all JH encoders

[2] "Exposed" linear encoders: TTL/11 µApp switchover (adjustment/ testing)

9.24 Adapter Cable 12-Pin/14-Pin; PWM to Encoders with M12 Connectors (1 Vpp / TTL)

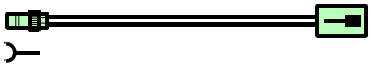
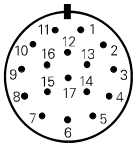
Adapterkabel ID 352611-xx ***Adapter cable ID 352611-xx***				
		Pos.Enc.  Pos.Enc.		
	Signal TTL	**Signal 1 Vss** ***Signal 1 Vpp***	**Farbe** ***Color***	
Stecker M12 14-pol. *14-pin connector M12*				Stecker 12-pol. *12-pin connector*
PIN 8	-Ua2	B-	rosa / *pink*	PIN 1
PIN 14	Sensor U_P	Sensor U_P	blau / *blue*	PIN 2
PIN 3	+Ua0	R+	rot / *red*	PIN 3
PIN 4	-Ua0	R-	schwarz / *black*	PIN 4
PIN 5	+Ua1	A+	braun / *brown*	PIN 5
PIN 6	-Ua1	A-	grün / *green*	PIN 6
PIN 10	-UaS	-UaS [1)]	violett / *violet*	PIN 7
PIN 7	+Ua2	B+	grau / *grey*	PIN 8
PIN 9	-	-	gelb / *yellow*	PIN 9
PIN 12	0 V	0 V	weiß/grün *white/green*	PIN 10
PIN 13	Sensor 0 V	Sensor 0 V	weiß / *white*	PIN 11
PIN 11	U_P	U_P	braun/grün *brown/green*	PIN 12
PIN 1/2	frei / *free*			

[1)] Not used by all JH encoders

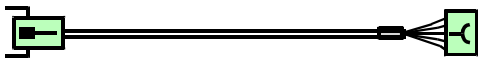
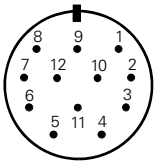
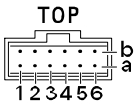
Note

The 1 Vpp and TTL interfaces use the same adapter cables!

9.25 Adapter Cable 17-Pin/14-Pin; PWM to Encoders with M12 Connectors (EnDat)

Adapterkabel ID 533631-xx ***Adapter cable ID 533631-xx***			
Pos.Enc.  Pos.Enc.			
	EnDat	**Farbe** ***Color***	
Stecker M12 14-pol. *14-pin connector M12*			Stecker 17-pol. *17-pin connector*
PIN 14	+V Sensor	blau / *blue*	PIN 1
-	frei / *free*	-	PIN 2
-	frei / *free*	-	PIN 3
PIN 13	0 V Sensor	weiß / *white*	PIN 4
-	frei / *free*	-	PIN 5
-	frei / *free*	-	PIN 6
PIN 11	+V (U_P)	braun/grün *brown/green*	PIN 7
PIN 10	CLOCK+	violett / *violet*	PIN 8
PIN 9	CLOCK-	gelb / *yellow*	PIN 9
PIN 12	0 V (U_N)	weiß/grün *white/green*	PIN 10
-	frei / *free*	-	PIN 11
PIN 7	B+	blau/schwarz *blue/black*	PIN 12
PIN 8	B-	rot/schwarz *red/black*	PIN 13
PIN 2	DATA+	grau / *grey*	PIN 14
PIN 5	A+	grün/schwarz / *green/black*	PIN 15
PIN 6	A-	gelb/schwarz *yellow/black*	PIN 16
PIN 1	DATA-	rosa / *pink*	PIN 17

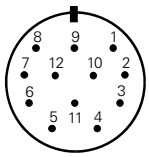
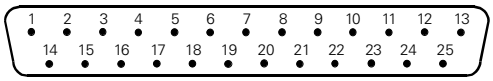
9.26 Adapter Cable 12-Pin/12-Pin; PWM to PCB Connector (1 Vpp, TTL, HTL) (Pos.Enc.)

Adapterkabel ID 591118-xx ***Adapter cable ID 591118-xx***				
Pos.Enc.  Pos.Enc.				
	**SignalH TL**	**Signal 1 Vss** ***Signal 1 Vpp***	**Farbe** ***Color***	
Stecker 12- pol. *12- pin connector*				Stecker12- pol. *12- pin connector*
PIN 1	-Ua2	B-	rosa /*pink*	PIN5a
PIN 2	SensorU_P	+ V Sensor	blau / *blue*	PIN2b
PIN 3	+Ua0	R+	rot / *red*	PIN4b
PIN 4	-Ua0	R-	schwarz / *black*	PIN4a
PIN 5	+Ua1	A+	braun /*brown*	PIN6b
PIN 6	-Ua1	A-	grün /*green*	PIN6a
PIN 7	-UaS	-UaS	violett /*violet*	PIN3a
PIN 8	+Ua2	B+	grau /*grey*	PIN5b
PIN 9	-	-	-	PIN3b
PIN10	U_N	0 V (U_N)	weiß/grün *white/green*	PIN1a
PIN11	SensorU_N	0 V Sensor	weiß / *white*	PIN1b
PIN12	U_P	+ V(U_P)	braun/grün *brown/green*	PIN2a

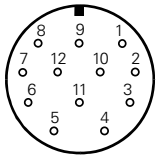
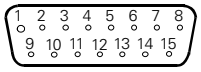
Note

Application example:
Encoder without commutation signals with 1 Vpp, TTL, HTL interface.
Encoders e.g.: ERN 138x, ERN 133x, ERN 132x.

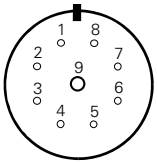
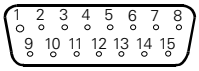
9.27 Adapter Cable 25-Pin D-Sub (Mot.Enc.); 12-pPin (Pos.Enc.) for PWM IN

Adapterkabel ID 533055 - 01 ***Adapter cable ID 533055 -01***				
Pos.Enc. Mot.Enc.				
	**Signal 1 Vss** ***Signal 1 Vpp***	**Signal TTL**	**Farbe** ***Color***	
Stecker 12 pol. *12- pin connector*				Sub-D-Stecker 25-pol. *25-pin D-sub connector*
PIN 1	B-	-Ua2	rosa / *pink*	PIN 7
PIN 2	5 V Sensor	Sensor U_P	blau / *blue*	PIN 14
PIN 3	R+	+Ua0	rot / *red*	PIN 17
PIN 4	R-	-Ua0	schwarz / *black*	PIN 18
PIN 5	A+	+Ua1	braun / *brown*	PIN 3
PIN 6	A-	-Ua1	grün / *green*	PIN 4
PIN 7	frei / *free*	frei / *free*		-
PIN 8	B+	+Ua2	grau / *grey*	PIN 6
PIN 9	frei / *free*	frei / *free*		-
PIN 10	0 V U_N	0 V	weiß/grün *white/green*	PIN 2
PIN 11	0 V Sensor	Sensor 0 V	weiß / *white*	PIN 16
PIN 12	5 V U_P	U_P	braun/grün *brown/green*	PIN 1
Gehäuse *Housing*	Schirm *Shield*	Schirm *Shield*		Gehäuse *Housing*
				PIN 5, 8, 9, 10, 11, 12, 13, 15, 19-25 frei / *free* nicht belegt /*not used*

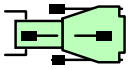
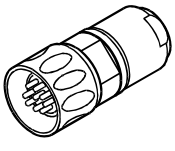
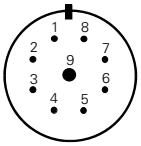
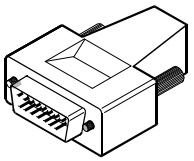
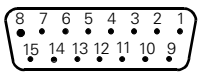
9.28 Adapter Cable 15-Pin D-Sub (Pos.Enc.); 12-Pin (Pos.Enc.) for PWM OUT

Adapterkabel ID 310199-xx ***Adapter cable ID 310199-xx***				
Pos.Enc. Pos.Enc.				
	**Signal 1 Vss** ***Signal 1 Vpp***	**Signal TTL**	**Farbe** ***Color***	
Stecker 12-pol. Buchse *12-pin female connector*				Sub-D-Stecker 15-pol. Buchse *15-pin D-sub connector (female)*
PIN 1	B-	-Ua2	rosa / *pink*	PIN 7
PIN 2	5 V Sensor	Sensor U_P	blau / *blue*	PIN 9
PIN 3	R+	+Ua0	rot / *red*	PIN 10
PIN 4	R-	-Ua0	schwarz / *black*	PIN 12
PIN 5	A+	+Ua1	braun / *brown*	PIN 3
PIN 6	A-	-Ua1	grün / *green*	PIN 4
PIN 7	frei / *free*	- UaS	violett / *violet*	PIN 14
PIN 8	B+	+Ua2	grau / *grey*	PIN 6
PIN 9	frei / *free*	frei / *free*		-
PIN 10	0 V U_N	0 V	weiß/grün *white/green*	PIN 2
PIN 11	0 V Sensor	Sensor 0 V	weiß / *white*	PIN 11
PIN 12	5 V U_P	U_P	braun/grün *brown/green*	PIN 1
Gehäuse *Housing*	Schirm *Shield*	Schirm *Shield*		Gehäuse *Housing*
				PIN 5, 8, 13, 15 frei / *free* nicht belegt / *not used*

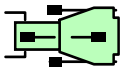
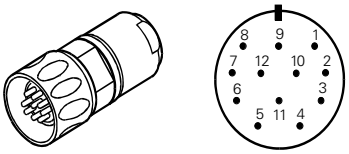
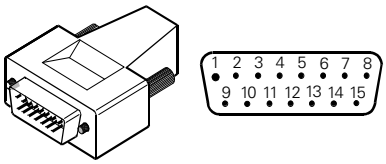
9.29 Adapter Cable 15-Pin D-Sub (Pos.Enc.); 9-Pin (Pos.Enc.) for PWM OUT

Adapterkabel ID 310198-xx ***Adapter cable ID 310198-xx***			
Pos.Enc. Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 9-pol. Buchse *9-pin female connector*			Sub-D-Stecker 15-pol. Buchse *15-pin D-sub connector (female)*
PIN 1	I_1 +	grün / *green*	PIN 3
PIN 2	I_1 -	gelb / *yellow*	PIN 4
PIN 3	5 V U_P	braun / *brown*	PIN 1
PIN 4	0 V U_N	weiß / *white*	PIN 2
PIN 5	I_2 +	blau / *blue*	PIN 6
PIN 6	I_2 -	rot / *red*	PIN 7
PIN 7	I_0 +	grau / *grey*	PIN 10
PIN 8	I_0 -	rosa / *pink*	PIN 12
PIN 9	Innenschirm / *Internal shield*	weiß/braun *white/brown*	PIN 5
Gehäuse *Housing*	Außenschirm *External shield*		Gehäuse *Housing*
			PIN 8, 9, 11, 13, 14, 15 frei / *free* nicht belegt /*not used*

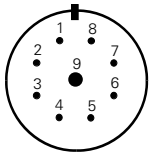
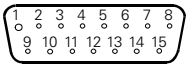
9.30 Round Adapter, 9-Pin/15-Pin D-Sub Connector (Pos.Enc./Pos.Enc) (11 µApp)

Adapter ID 294894-02 ***Adapter ID 294894-02***		
Pos.Enc. Pos.Enc. 		
 	**Signal**	 
Stecker 9 - pol. *9-pin connector*		Sub-D - Stecker 15-pol. *15 -pin D-sub connector*
PIN 1	I_1 +	PIN 3
PIN 2	I_1 -	PIN 4
PIN 3	5 V U_P	PIN 1
PIN 4	0 V U_N	PIN 2
PIN 5	I_2 +	PIN 6
PIN 6	I_2 -	PIN 7
PIN 7	I_0 +	PIN 10
PIN 8	I_0 -	PIN 12
PIN 9	Innenschirm *Internal shield*	PIN 5
Gehäuse *Housing*	Außenschirm *External shield*	Gehäuse *Housing*
		PIN 8, 9, 11, 13, 14, 15 frei /*free* nicht belegt /*not used*

9.31 Round Adapter, 12-Pin/15-Pin D-Sub Connector (Pos.Enc./Pos.Enc) (1 Vpp / TTL)

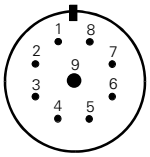
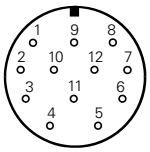
Adapter ID 324555-01 ***Adapter ID 324555-01***			
Pos.Enc. Pos.Enc. 			
	**Signal 1 Vss** ***Signal 1 Vpp***	**Signal TTL**	
Stecker 12-pol. *12-pin connector*			Sub-D-Stecker 15-pol. *15-pin D-sub connector*
PIN 1	B-	-Ua2	PIN 7
PIN 2	5 V Sensor	5 V Sensor	PIN 9
PIN 3	R+	+Ua0	PIN 10
PIN 4	R-	-Ua0	PIN 12
PIN 5	A+	+Ua1	PIN 3
PIN 6	A-	-Ua1	PIN 4
PIN 7	- UaS	- UaS	PIN 14
PIN 8	B+	+Ua2	PIN 6
PIN 9	frei / *free*	frei / *free*	-
PIN 10	0 V U_N	0 V U_N	PIN 2
PIN 11	0 V Sensor	0 V Sensor	PIN 11
PIN 12	5 V U_P	5 V U_P	PIN 1
Gehäuse *Housing*	Schirm *Shield*	Schirm *Shield*	Gehäuse *Housing*
			PIN 5, 8, 13, 15 frei / *free* nicht belegt / *not used*

9.32 Adapter Cable TTL/D-Sub 15-Pin (Pos.Enc.) --> 11 µApp M23 9-Pin (Pos.Enc.)

Umschalt-Adapterkabel Id.Nr. 331692-xx ***Adapter cable for 1Vpp/11µApp change-over Id.Nr. 331692-xx***			
Pos.Enc. Pos.Enc.			
	**Signal**	**Farbe** ***Color***	
Stecker 9-pol. *9-pin connector*			Sub-D-Stecker 15-pol. Buchse *15-pin D-sub connector (female)*
PIN 1	I_1 +	grün / *green*	PIN 1
PIN 2	I_1 -	gelb / *yellow*	PIN 9
PIN 3	5 V U_P	braun / *brown*	PIN 4 PIN 15 [1)]
PIN 4	0 V U_N	weiß / *white*	PIN 2
PIN 5	I_2 +	blau / *blue*	PIN 3
PIN 6	I_2 -	rot / *red*	PIN 11
PIN 7	I_0 +	grau / *grey*	PIN 14
PIN 8	I_0 -	rosa / *pink*	PIN 7
PIN 9	Innenschirm / *Internal shield*	weiß/braun *white/brown*	PIN 5
Gehäuse *Housing*	Außenschirm *External shield*		Gehäuse *Housing*
			PIN 6, 8, 10, 12, 13 frei / *free* nicht belegt / *not used*

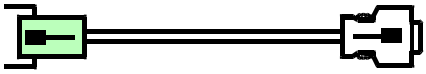
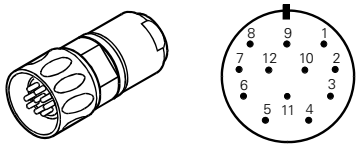
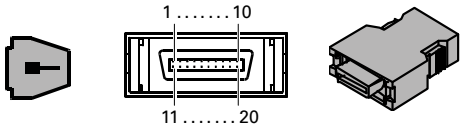
[1)] PIN 4 and PIN 15 bridged. 5 V switchover voltage at PIN 15 (TTL –> 11 µApp)

9.33 Adapter TTL M23 12-Pin (Pos.Enc.) --> 11 µApp M23 9-Pin (Pos.Enc.)

Umschalt-Adapter ID 324282-xx ***Adapter for 1Vpp/11µApp changeover ID 324282-xx***			
Pos.Enc.			Pos.Enc.
	**Signal**	**Farbe** ***Color***	
Stecker 9-pol. *9-pin connector*			Kupplung 12-pol. Buchse *12-pin coupling connector (female)*
PIN 1	I_1 +	grün / *green*	PIN 5
PIN 2	I_1 -	gelb / *yellow*	PIN 6
PIN 3	5 V U_P	braun / *brown*	PIN 9 [1)] PIN 12
PIN 4	0 V U_N	weiß / *white*	PIN 10
PIN 5	I_2 +	blau / *blue*	PIN 8
PIN 6	I_2 -	rot / *red*	PIN 1
PIN 7	I_0 +	grau / *grey*	PIN 3
PIN 8	I_0 -	rosa / *pink*	PIN 4
PIN 9	Innenschirm *Internal shield*	Innenschirm *Internal shield*	
Gehäuse *Housing*		Außenschirm *External shield*	Gehäuse *Housing*
			PIN 2, 7, 11 frei / *free* nicht belegt / *not used*

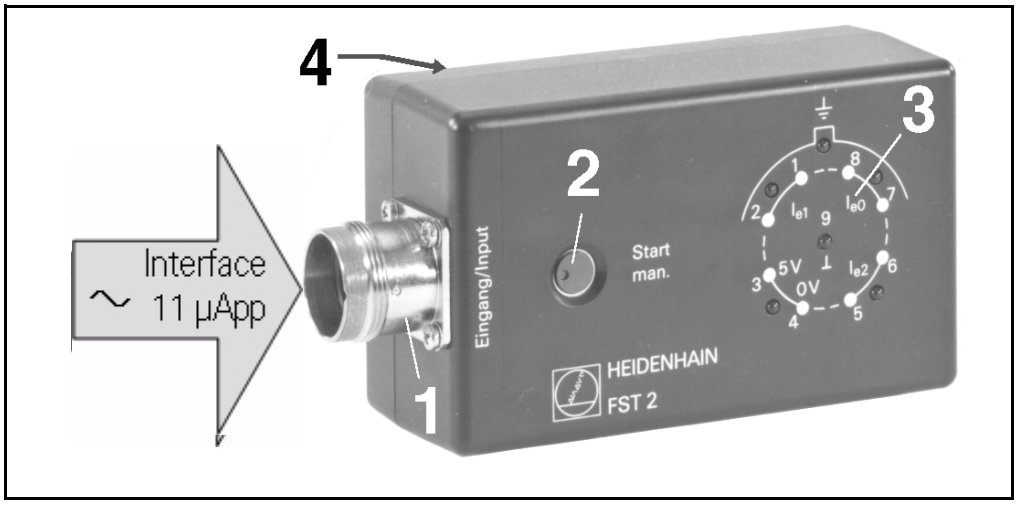
[1)] PIN 9 and PIN 12 bridged. 5 V switchover voltage at PIN 9 (TTL –> 11 µApp)

9.34 Adapter Cable FANUC TTL 20-Pin/ HEIDENHAIN TTL 12-Pin

Adapterkabel ID 577345-01 ***Adapter cable ID 577345-01***		
		
	**Signal TTL**	
Stecker 12-pol. *12-pin connector*		FANUC TTL 20-pol. *20-pin FANUC TTL*
PIN 1	-Ua2	PIN 4
PIN 2	5 V Sensor	PIN 18, 20
PIN 3	+Ua0	PIN 5
PIN 4	-Ua0	PIN 6
PIN 5	+Ua1	PIN 1
PIN 6	-Ua1	PIN 2
PIN 7	- UaS	-
PIN 8	+Ua2	PIN 3
PIN 9	frei / *free*	-
PIN 10	0 V U_N	PIN 12
PIN 11	0 V Sensor	PIN 14
PIN 12	5 V U_P	PIN 9
Gehäuse *Housing*	Schirm *Shield*	PIN 16
		PIN 7, 8, 10, 11, 13, 15, 17, 19 frei / *free* nicht belegt / *not used*

10 FST 2 Leak Tester

10.1 Description



The leak tester serves to check NC linear and rotary encoders with 11 µApp interface and 9-pin output connector for leak currents (up to 3 MΩ) in the cables or on the photocell board (e.g. humidity from coolant causing "short circuits" in the connector housing or on boards in the kΩ or MΩ range.

The FST 2 automatically switches on when a test item (e.g. a linear encoder) is connected. The lamp (LED) current of the encoder is used for this purpose.

For units without lamp (e.g. for connecting cables, or if the light unit is defective) the automatic test procedure is not activated. In this event the "Start man." button must be pressed.

Note

On encoders with integrated amplifier only leak currents between internal shield () and external shield (⏚) can be measured.

Due to the internal resistance (< 3 MΩ) of the amplifier the four remaining LEDs always indicate leak current when a test item is connected.

10.2 Explanation of the Control Elements

1 Female input connector, 9-pin
For connecting encoders with sinusoidal output signals and extension cables with 9-pin connector.

2 Manual Start button
When testing items with LED or encoders with defective lamp the manual start button has to be pressed to activate the FST 2. The FST 2 is active as long as the button is pressed.

The manual start button also serves to check the battery. The battery voltage is OK, if the LEDs light up like running light as long as the key is pressed.

3 LED display
Leak circuits are indicated by the LEDs being permanently lit. The running light signalizes that there is no leak current in the test item.

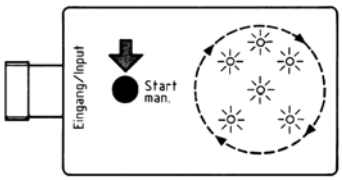
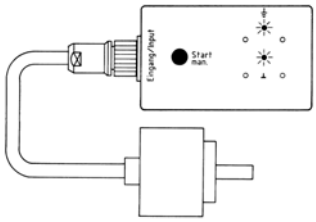
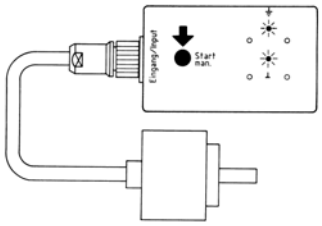
The imprint on the FST 2 housing gives information on the where a leak current was detected.

4 Quick reference guide
Brief operating instructions are printed onto the back side of the FST 2.
A sticker with instructions in English language is supplied with the unit.

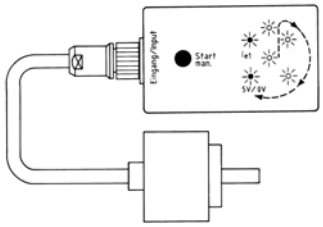
10.3 Application Example

Measurement of a rotary encoder having the following leak currents:

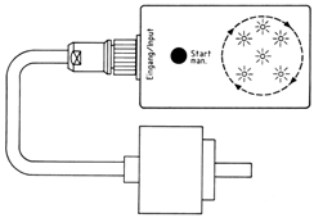
- Leak current between ⊥ and ⏚
- Leak current between Ie1 and 0 V / 5 V

Instructions	Display (Anzeige)	Error cause
Battery test: Press Manual Start button.		LED running light = battery functions properly LEDs dark = battery defective
Connect encoder, test starts automatically.		Leak current between ⊥ and ⏚ is displayed. (leak current 1)
Test does not start. (LEDs dark) Press Manual Start button to to start the test.		Encoder light unit defective or connection to light unit interrupted. Leak current between ⊥ and ⏚ is displayed. (leak current 1)

Eliminate leak current from the rotary encoder!

Connect encoder, test starts automatically.		The running light stops at LED 0 V / 5 V. A leak current between 0 V / 5 V and Ie1 is displayed by permanently lit LEDs 0 V / 5 V and Ie1 (leak current 2).

Eliminate leak current 2 from the rotary encoder!

Connect encoder, test starts automatically.		Each of the 6 LEDs lights up for a moment (running light) as long as the rotary encoder is connected or the Start man. button is pressed. **Rotary encoder without leak current!**

Note

After repair the measurement must be repeated until a running light forms from all LEDs. Then the test item does not have any leak currents!

10.4 Specifications

Sensitivity
Leak currents ≤ 3 MΩ

Sequence of measurements
1. ⊥
2. ⏚
3. Ie0
4. Ie2
5. 0 V / 5 V
6. Ie1

Measuring cycle
1 second

Power supply
9 V battery
Exchange the battery every 2 years; use leak-proof branded batteries (e.g. ALKALINE).

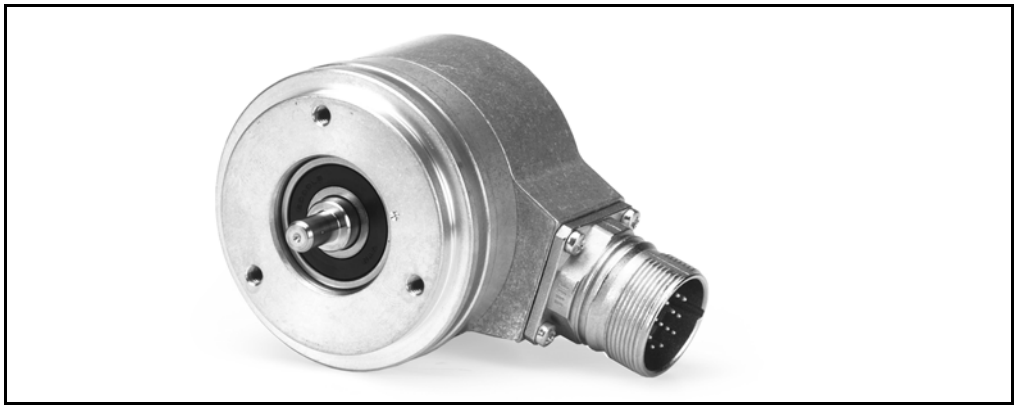
Battery voltage
≥ 5.5 V
Below 5.5 V the device is inactive!

Current consumption
10 mA (operation)
≤ 0.1 µApp (quiescent current)

Cable lengths
Depend on capacitance

11 Rotary Encoder ROD 486

11.1 Description

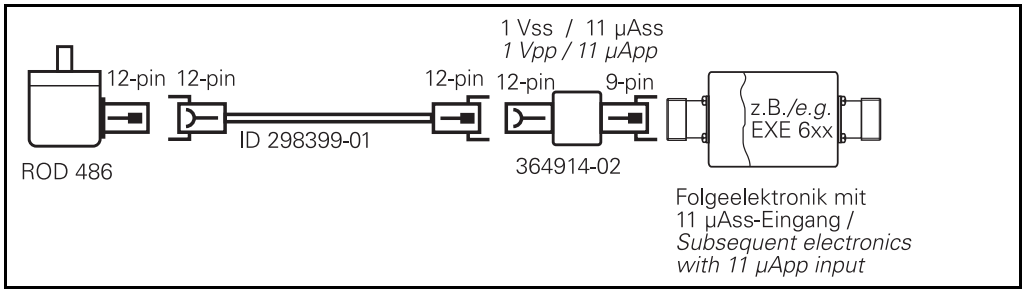


With the ROD 486 you can check counting function and interpolation settings of ND, VRZ, IBV, EXE, etc. with 1 Vpp interface.

The ROD 486 can be used to preset oscilloscope triggering for checking the reference mark with PWM.

Note

With the adapter 1 Vpp / 11 µApp (interface converter) ID 364914-02 and the 12-pin connecting cable ID 298399-01 subsequent electronics with 11 µApp interface can be inspected.



11.2 Specifications

Power supply

Power supply	5 V ± 10 % max. 120 mA

Output signals

Incremental signals A / B	0.8 - 1.2 Vpp
Reference signal Ie0	0.2 - 0.85 V (usable component)

Line count

1000 lines/rev.
1 reference signal/revolution

Electrical connection

Radial flange socket
(The connecting cable ID 298399-01 can be used as extension cable.)

12 Specifications

12.1 PWM 9 Basic Unit

Power supply at the DC-IN socket

Supply voltage range	10 - 30 V
Current consumption of PWM 9 with interface board 1 Vpp ID 323077-02 without encoder	Approx. 250 mA with 24 V Approx. 470 mA with 12 V Switch-on current approx. 1 A
Power consumption with PWM power supply unit ID 313797-01	approx. 15 W

Power supply of PWM via the OUT flange socket of the interface board

Supply voltage range	3 - 10 V (11 µApp, 1 Vpp, TTL) 10 - 30 V (check HTL!)
Current consumption of PWM 9 in PWM MODE with interface board 1 Vpp ID 323077-02 without encoder and without display lighting with display lighting with bright display lighting (Rv = 5 instead of 10 Ω)	 Approx. 1.3 A (approx. 6.5 W) with 5 V Approx. 1.6 A (approx. 8 W) with 5 V Approx. 1.8 A (approx. 9 W) with 5 V

Encoder power supply

Note

Parameter P2: U-MSYS EXTERNAL set to floating

Encoder voltage (11 µApp,1 Vpp, TTL)	3 - 9 V, can be set by hand **Default setting** 5 V ± 0.1 V
Encoder voltage (HTL) (without voltage prescribed by subsequent electronics)	10 - 19 V selectable with 24 V PWM power supply unit 10 - 25 V selectable if 30 V at DC-IN **Default setting** 12 V ± 0.2 V
Encoder voltage (HTL) with voltage of subsequent electronics	10 - 25 V selectable with 30 V power supply

Note

When the PWM 9 is switched on, it adapts the PWM encoder voltage to the voltage of the subsequent electronics.
Subsequent electronics (OUT) 4.8 V, encoder voltage (IN) 4.8 V.

Current limiting

Encoder current limit Encoder current limit with active terminating resistor	Max. 500 mA Max. 700 mA

Frequency display

Measuring range of frequency counter	20 Hz - 2 MHz

Frequency range of UNIVERSAL COUNTER

Maximum input frequency	Approx. 2 MHz

Frequency range of DETERMINE PULSE NUMBER

Maximum input frequency (Observe the maximum input frequency of the interface board)	1 MHz

PHA, TV1, TV2 bar display

Measuring ranges in degrees [°]	5, 10, 25, 50, autom. measuring range **Default setting** ± 50°
Frequency range	10 Hz - 10 MHz

PWT bar display of ref. mark width and position

Frequency range	15 Hz - 100 kHz
Max. number of ref. mark measurements	$15\ \frac{\text{Reference signals}}{\text{s}}$
Ref. signal processing time	70 ms

Note

If $15\ \frac{\text{Reference signals}}{\text{s}}$ is exceeded, the evaluation process ignores these reference mark signals. If the reference mark spacing is less than 70 ms, the error message FREQU> is displayed. (Example: Distance-coded reference marks)

Accuracy of PHA/TV display

Interface board	Frequency	TV	PHA
TTL, HTL	10 Hz - 10 kHz 10 kHz - 500 kHz 500 kHz - 1 MHz	± 0,5° ± 2° ± 3°	± 0,5° ± 2° ± 3°
11 µApp, 1 Vpp	10 Hz - 10 kHz 10 kHz - 500 kHz 500 kHz - 1 MHz	± 1° ± 3° ± 5°	± 3° ± 5° ± 5°

Note

The specified tolerances are valid within the calibration cycle.
(See "Calibration" on page 10).

Temperature range

Operating temperature	0 °C to + 40 °C
Storage temperature	– 20 °C to + 60 °C

Display contrast The contrast of the LCD can be adjusted. The trimmer is located next to the "C" BNC socket.

Note

An adjustment tool or a watchmaker's screwdriver is required for trimming!

12.2 11 µApp Interface Board

Signal amplification (Ie1, Ie2, Ie0)

$$300\ \frac{\mathrm{mV}}{\mu\mathrm{A}}$$

Input amplifier

Maximum signal current	Ie0, Ie1, Ie2: 66 µApp

Maximum input frequency

–3 dB	Approx. 300 kHz

Note

The maximum input frequency only specifies the current-to-voltage converter of the PWM 9 (signal source: frequency generator). In real operation with measuring systems the frequency response highly depends on the photocells, on the capacitance of the photocells and on the cable length.

Measure current/voltage

Current range	0 - 500 mA
Voltage range	0 - 10 V
Tolerance	± 3 %

Measure signal amplitudes

PWT MODE range	0 µApp – 16.9 µApp
PWM MODE range	2 µApp – 33.3 µApp (equal to 0.6 - 10 Vpp)
Measuring frequency Min. measuring frequency Max. measuring frequency -3dB	 10 Hz 100 kHz
Tolerance with software adjustment	±3 % for measuring frequencies up to 20 kHz ±10 % for measuring frequencies up to 50 kHz

Note

The specified tolerances are valid within the calibration cycle.
(See "Calibration" on page 10).

Display of $\overline{\text{UaS}}$ interference signal

Ie1 and Ie2	< 4 µApp
Response time of the interface board	t1 approx. 5 µs
Response time of PWM display	t2 > 1.2 µs
Minimum duration of interference to display $\overline{\text{UaS}}$	t > 6.2 µs (= t1 + t2)
Interference display in PWT MODE "SIGNALS TOO LARGE"	16.1 µApp

Encoder output

Output signal	Like input signal **without** U_0 with 0 V reference potential

12.3 1 Vpp Interface Board

Encoder input (IN)

Signal voltage	Max. 5 Vpp

Maximum input frequency

Max. frequency for the encoder input of the interface board (-3 dB)	Approx. 500 kHz
Max. frequency for the analog signals on the BNC sockets (- 3 dB)	Approx. 1 MHz

Note

Higher input frequencies (up to 1 MHz) are possible, however the accuracy of the PHA/TV display can no longer be guaranteed!
The maximum input frequency only specifies the voltage input of PWM 9 (signal source: frequency generator). In real operation with measuring systems the frequency response highly depends on the encoder model and on the cable length.

Measure current/voltage

Current range	0 - 500 mA
Voltage range	0 - 10 V
Tolerance	± 3 %

Note

The specified tolerances are valid within the calibration cycle.
(See “Calibration” on page 10).

Measure signal amplitudes

Measuring range	0.2 Vpp - 1.6 Vpp
Measuring frequency Min. measuring frequency Max. measuring frequency -3dB	 10 Hz 100 kHz
Tolerance with software adjustment	±3 % for measuring frequencies up to 20 kHz ±10 % for measuring frequencies up to 50 kHz

Terminating resistor

121 Ω

Display of $\overline{\text{UaS}}$ interference signal

Incremental signals A and B	< 0.3 Vpp
Response time of the interface board	t1 approx. 5 µs
Response time of PWM display	t2 > 1.2 µs
Minimum duration of interference to display $\overline{\text{UaS}}$	t > 6.2 µs (= t1 + t2)

Encoder output

Output signal	Like input signal **with** U_0

Note

The specified tolerances are valid within the calibration cycle.
(See "Calibration" on page 10).

12.4 1 Vpp Absolute Interface Board

Encoder input (IN)

Signal voltage	Max. 5 Vpp

Maximum input frequency

Input frequency for 1 Vpp signals (- 3 dB)	Approx. 500 kHz
Max. frequency for the analog signals on the BNC sockets	Approx. 1 MHz (3 dB)

Note

Higher input frequencies (up to 1 MHz) are possible; however, the tolerance of the PHA/TV display can no longer be guaranteed!

The maximum input frequency only specifies the voltage input of PWM 9 (signal source: frequency generator). In real operation with measuring systems the frequency response highly depends on the encoder model and on the cable length.

Encoder output (OUT)

Output signal	Like input signal **without** U_0

Assignment of the BNC sockets

1 Vpp encoder, AB track

Signals on BNC socket A	A, B, A+B, R
Signals on BNC socket B	B, A, A+B, R
Signals on BNC socket C	R, $\overline{\text{UaS}}$, Up

1 Vpp encoder, CD track

Signals on BNC socket A	C, D, C+D, R
Signals on BNC socket B	D, C, C+D, R
Signals on BNC socket C	R, $\overline{\text{UaS}}$, Up

1 Vpp encoder with EnDat or SSI interface

Signals on BNC socket A	A, CLK+, DAT+, DAT–
Signals on BNC socket B	B, CLK-, DAT+, DAT–
Signals on BNC socket C	$\overline{\text{UaS}}$, Up, CLK–, CLK+

Measure current/voltage

Current range	0 - 500 mA
Voltage range	0 - 30 V
Tolerance	± 5 %

Measure signal amplitudes

Measuring range	0.2 Vpp - 1.6 Vpp
Measuring frequency Min. measuring frequency Max. measuring frequency -3dB	 10 Hz 100 kHz
Tolerance with software adjustment	±3 % for measuring frequencies up to 20 kHz ±10 % for measuring frequencies up to 50 kHz

Display of $\overline{\text{UaS}}$ interference signal

Incremental signals A and B	< 0.3 Vpp
Response time of the interface board	t_1 approx. 5 µs
Response time of PWM display	t_2 > 1.2 µs
Minimum duration of interference to display /UaS	t > 6.2 µs (= t_1 + t_2)

Terminating resistor

Incremental signals A / B	121 Ω
Incremental signals C / D	1 kΩ

Note

The specified tolerances are valid within the calibration cycle.
(See “Calibration” on page 10).

12.5 TTL Interface Board

Maximum input voltage

Maximum input voltage	± 7 V

Maximum input frequency

Maximum input frequency	Approx. 2 MHz

Note

The maximum input frequency only specifies the voltage input of PWM 9 (signal source: frequency generator).

Measure current/voltage

Current range	0 - 500 mA
Voltage range	0 - 10 V
Tolerance	± 3 %

Note

The specified tolerances are valid within the calibration cycle.
(See "Calibration" on page 10).

Measure signal amplitudes

High-level measuring range	2.5 - 7.5 V
Low-level measuring range	0 - 2.5 V
Resolution	50 mV
Measuring frequency	10 Hz - 200 kHz
Tolerance	± 50 mV

Terminating resistor

From encoder signal to U-MSYS	215 Ω
From encoder signal to GND	90.9 Ω

Note

Special feature of TTL interface board
Owing to the input circuit the PHA/TV display is fully operative even in the event of a cable breakage (e.g. $\overline{Ua1}$). The missing signals are generated internally and entirely output at the encoder output. A cable breakage can be detected in the mode MEASURE SIGNAL AMPLITUDE or by checking the encoder signals at the BNC sockets.

12.6 HTL Interface Board

Maximum input voltage

Maximum input voltage	0 - 30 V

Maximum input frequency

Maximum input frequency	Approx. 2 MHz

Note

The maximum input frequency only specifies the voltage input of PWM 9 (signal source: frequency generator).

Measure current/voltage

Current range	0 - 500 mA
Voltage range	0 - 30 V
Tolerance	± 5 %

Note

The specified tolerances are valid within the calibration cycle.
(See "Calibration" on page 10).

Measure signal amplitudes

High-level measuring range	7.5 - 22.5 V
Low-level measuring range	0 - 7.5 V
Resolution	100 mV
Measuring frequency	10 Hz - 200 kHz
Tolerance	± 100 mV

Terminating resistor

From encoder signal to U-MSYS	1200 Ω
From encoder signal to GND	1200 Ω

Note

Special feature of HTL interface board
If the inverted encoder signals are missing at the encoder inputs, these signals are generated internally and output to the encoder output.

12.7 PWM Power Supply Unit

Input voltage	100 - 240 V AC, 50 - 60 Hz
Output voltage	24 Vdc, 1.0 A
Protection class	1
Max. ambient temperature	40 °C

Required EMC standards

EN 61000-6-2

Immunity for industrial environments

In detail:

EN 61000 - 4 - 2 ES level 3
EN 61000-4-3 Radiation level 3
EN 61000-4-4 Burst level 3
EN 61000-4-5 Surge level 3
EN 61000-4-6 Radio frequency induction level 3

EN 55011 Class B

Noise suppression

13 Contact

Your HEIDENHAIN helpline

The **HEIDENHAIN helpline** in Traunreut consists of qualified, multi-lingual specialists who will support you in solving your problems.

Especially if you need **technical support** the HEIDENHAIN helpline team can provide detailed advice and information on measuring systems, controls, and NC and PLC programming.

The HEIDENHAIN technical helpline

Measuring Systems / Machine Calibration
+49 (8669) 31-3104
E-mail: service.ms-support@heidenhain.de

NC Programming
+49 (8669) 31-3103
E-mail: service.nc-pgm@heidenhain.de

NC Support
+49 (8669) 31-3101
E-mail: service.nc-support@heidenhain.de

PLC Programming for TNC
+49 (8669) 31-3102
E-mail: service-plc@heidenhain.de

Lathe Controls
+49 (8669) 31-3105
E-mail: service.lathe-support@heidenhain.de

The HEIDENHAIN helpline for repairs, spare parts, exchange units, complaints and service contracts

Domestic Team
+49 (8669) 31-3121

Foreign Team
+49 (8669) 31-3123

Complaint management, service contracts and calibration services
+49 (8669) 31-3135

E-mail: service.order@heidenhain.de

Technical training

+49 (8669) 31-2293, 31-1695
Fax: +49 (8669) 31-1999
E-mail: mtt@heidenhain.de

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Germany
☏ +49 8669 31-0
FAX +49 8669 5061
E-mail: info@heidenhain.de

www.heidenhain.de

Vollständige und weitere Adressen siehe www.heidenhain.de
For complete and further addresses see www.heidenhain.de

DE **HEIDENHAIN Vertrieb Deutschland**
83301 Traunreut, Deutschland
☏ 08669 31-3132
FAX 08669 32-3132
E-Mail: hd@heidenhain.de

HEIDENHAIN Technisches Büro Nord
12681 Berlin, Deutschland
☏ 030 54705-240

HEIDENHAIN Technisches Büro Mitte
08468 Heinsdorfergrund, Deutschland
☏ 03765 69544

HEIDENHAIN Technisches Büro West
44379 Dortmund, Deutschland
☏ 0231 618083-0

HEIDENHAIN Technisches Büro Südwest
70771 Leinfelden-Echterdingen, Deutschland
☏ 0711 993395-0

HEIDENHAIN Technisches Büro Südost
83301 Traunreut, Deutschland
☏ 08669 31-1345

AR **NAKASE SRL.**
B1653AOX Villa Ballester, Argentina
www.heidenhain.com.ar

AT **HEIDENHAIN Techn. Büro Österreich**
83301 Traunreut, Germany
www.heidenhain.de

AU **FCR Motion Technology Pty. Ltd**
Laverton North 3026, Australia
E-mail: vicsales@fcrmotion.com

BA Bosnia and Herzegovina → **SL**

BE **HEIDENHAIN NV/SA**
1760 Roosdaal, Belgium
www.heidenhain.be

BG **ESD Bulgaria Ltd.**
Sofia 1172, Bulgaria
www.esd.bg

BR **DIADUR Indústria e Comércio Ltda.**
04763-070 – São Paulo – SP, Brazil
www.heidenhain.com.br

BY **Belarus**
GERTNER Service GmbH
50354 Huerth, Germany
www.gertnergroup.com

CA **HEIDENHAIN CORPORATION**
Mississauga, OntarioL5T2N2, Canada
www.heidenhain.com

CH **HEIDENHAIN (SCHWEIZ) AG**
8603 Schwerzenbach, Switzerland
www.heidenhain.ch

CN **DR. JOHANNES HEIDENHAIN (CHINA) Co., Ltd.**
Beijing 101312, China
www.heidenhain.com.cn

CZ **HEIDENHAIN s.r.o.**
102 00 Praha 10, Czech Republic
www.heidenhain.cz

DK **TP TEKNIK A/S**
2670 Greve, Denmark
www.tp-gruppen.dk

ES **FARRESA ELECTRONICA S.A.**
08028 Barcelona, Spain
www.farresa.es

FI **HEIDENHAIN Scandinavia AB**
02770 Espoo, Finland
www.heidenhain.fi

FR **HEIDENHAIN FRANCE sarl**
92310 Sèvres, France
www.heidenhain.fr

GB **HEIDENHAIN (G.B.) Limited**
Burgess Hill RH15 9RD, United Kingdom
www.heidenhain.co.uk

GR **MB Milionis Vassilis**
17341 Athens, Greece
www.heidenhain.gr

HK **HEIDENHAIN LTD**
Kowloon, Hong Kong
E-mail: sales@heidenhain.com.hk

HR Croatia → **SL**

HU **HEIDENHAIN Kereskedelmi Képviselet**
1239 Budapest, Hungary
www.heidenhain.hu

ID **PT Servitama Era Toolsindo**
Jakarta 13930, Indonesia
E-mail: ptset@group.gts.co.id

IL **NEUMO VARGUS MARKETING LTD.**
Tel Aviv 61570, Israel
E-mail: neumo@neumo-vargus.co.il

IN **HEIDENHAIN Optics & Electronics India Private Limited**
Chetpet, Chennai 600 031, India
www.heidenhain.in

IT **HEIDENHAIN ITALIANA S.r.l.**
20128 Milano, Italy
www.heidenhain.it

JP **HEIDENHAIN K.K.**
Tokyo 102-0083, Japan
www.heidenhain.co.jp

KR **HEIDENHAIN Korea LTD.**
Gasan-Dong, Seoul, Korea 153-782
www.heidenhain.co.kr

ME Montenegro → **SL**

MK Macedonia → **BG**

MX **HEIDENHAIN CORPORATION MEXICO**
20235 Aguascalientes, Ags., Mexico
E-mail: info@heidenhain.com

MY **ISOSERVE Sdn. Bhd**
56100 Kuala Lumpur, Malaysia
E-mail: isoserve@po.jaring.my

NL **HEIDENHAIN NEDERLAND B.V.**
6716 BM Ede, Netherlands
www.heidenhain.nl

NO **HEIDENHAIN Scandinavia AB**
7300 Orkanger, Norway
www.heidenhain.no

PH **Machinebanks` Corporation**
Quezon City, Philippines 1113
E-mail: info@machinebanks.com

PL **APS**
02-489 Warszawa, Poland
www.apserwis.com.pl

PT **FARRESA ELECTRÓNICA, LDA.**
4470 - 177 Maia, Portugal
www.farresa.pt

RO **HEIDENHAIN Reprezentanţă Romania**
Braşov, 500338, Romania
www.heidenhain.ro

RS Serbia → **BG**

RU **OOO HEIDENHAIN**
125315 Moscow, Russia
www.heidenhain.ru

SE **HEIDENHAIN Scandinavia AB**
12739 Skärholmen, Sweden
www.heidenhain.se

SG **HEIDENHAIN PACIFIC PTE LTD.**
Singapore 408593
www.heidenhain.com.sg

SK **KOPRETINA TN s.r.o.**
91101 Trencin, Slovakia
www.kopretina.sk

SL **Posredništvo HEIDENHAIN NAVO d.o.o.**
2000 Maribor, Slovenia
www.heidenhain-hubl.si

TH **HEIDENHAIN (THAILAND) LTD**
Bangkok 10250, Thailand
www.heidenhain.co.th

TR **T&M Mühendislik San. ve Tic. LTD. ŞTİ.**
34728 Umraniye-Istanbul, Turkey
www.heidenhain.com.tr

TW **HEIDENHAIN Co., Ltd.**
Taichung 40768, Taiwan R.O.C.
www.heidenhain.com.tw

UA **Gertner Service GmbH Büro Kiev**
01133 Kiev, Ukraine
www.gertnergroup.com

US **HEIDENHAIN CORPORATION**
Schaumburg, IL 60173-5337, USA
www.heidenhain.com

VE **Maquinaria Diekmann S.A.**
Caracas, 1040-A, Venezuela
E-mail: purchase@diekmann.com.ve

VN **AMS Co. Ltd**
HCM City, Vietnam
E-mail: davidgoh@amsvn.com

ZA **MAFEMA SALES SERVICES C.C.**
Midrand 1685, South Africa
www.heidenhain.co.za

517651-26 · Ver08 · 2 · 2/2012 · S · Printed in Germany